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THE
INTERNATIONAL ENCYCLOPÆDIA
OF
SURGERY.

VOL. VI.

THE

INTERNATIONAL ENCYCLOPÆDIA

OF

SURGERY

A SYSTEMATIC TREATISE

ON THE

THEORY AND PRACTICE OF SURGERY

BY

AUTHORS OF VARIOUS NATIONS

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EDITED BY

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IN SIX VOLUMES

VOL. VI.

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PREFACE.

THE Sixth and Last Volume of the ENCYCLOPÆDIA concludes the consideration of the Injuries and Diseases of the Various Regions of the Body, and supplies certain articles which were necessarily omitted from previous volumes, owing to the inability of their authors to complete them in time for insertion in their appropriate places.

The consideration of the Surgery of the Digestive Organs is completed by Articles on the Injuries and Diseases of the Œsophagus, by Prof. Solis-Cohen; on Intestinal Obstruction, by the Editor; and on Injuries and Diseases of the Rectum, by Mr. Allingham, of London. An exhaustive Article on Urinary Calculus is contributed by Prof. Keyes, of New York; and a short, special Article, based on personal experience of the Crushing Operation for Stone, by that veteran lithotritist, Prof. Hingston, of Montreal. The Surgery of the Bladder and Prostate is dealt with by Mr. Reginald Harrison, of Liverpool; that of the Male Urethra by Prof. Duplay, of Paris; and that of the Male Generative Organs by Mr. Royes Bell, of London. Three Articles are devoted to the Surgery of the Female Sexual Apparatus, contributed respectively by Prof. Parvin, who writes on Injuries and Diseases of the Female Genitals; by Dr. Robert P. Harris, who treats of the Cæsarean Section and allied operations—a subject of which he is known to have long made a special study; and by Dr. Charles C. Lee, of New York, who, when Dr. Mundé found himself unable to prepare the article on Ovarian and Uterine Tumors, most courteously acceded to the Editor's urgent request that he should undertake the task, and who, in spite of the harassing interruptions of a laborious and exacting practice, has furnished an account of the subject, remarkable alike for its condensation and its eminently practical character.

The material postponed from previous volumes embraces a series of three Articles on Diseases of the Bones, contributed by as many eminent surgeons of the Lyons School, Prof. Ollier, Prof. Vincent, and Prof. Poncet; and a comprehensive Article on the Treatment of Deformities, by the well-known orthopædic surgeon, Mr. F. R. Fisher, of London.

In an Appendix are included three Articles on subjects which, though not usually considered in surgical treatises, are in themselves of the highest interest and importance: these are the Construction and Organization of Hospitals, here dealt with in a concise and practical manner by Dr. Cowles, of the McLean Asylum; the Preparations to be made by Surgeons in time of War in entering upon Field Duty, with an Account of the Modern System of Ambulance Service, by Lieutenant-Colonel and Surgeon Clements, U. S. Army; and the History of Surgery, briefly but comprehensively reviewed by a writer justly famed for his erudition and profundity of antiquarian lore, Dr. George J. Fisher, of Sing Sing, N. Y.

The volume ends with an elaborate General Index, compiled by Dr. H. R. Wharton, which will facilitate reference to all parts of the entire work.

Two of the Editor's collaborators have died since the publication of the last volume: Surgeon BILL of the U. S. Army, whose Article on Sabre, Bayonet, and Arrow Wounds will always be classical; and, quite recently, the venerable Prof. POST, of New York, long a connecting link with a past generation of surgeons, but who despite his burden of years, which measurably exceeded the allotted three-score-and-ten, preserved full activity of mind and hand, and who, with the wisdom and long experience of age, was able to combine a boldness and operative skill which might well be envied by younger surgeons. The death-roll of Contributors to the Encyclopædia, actual or promised, now numbers ten—all the Editor's countrymen—whose names are reproduced here *in honorem*, a list of surgeons of whom America may well be proud: GROSS and VAN BUREN; OTIS and BILL; LIDELL and HODGEN; HODGE and HUNTER; POST and SIMS.

In completing his task, which has occupied all his leisure moments for more than six years, and has involved an amount of anxiety and labor which few can appreciate who have not been engaged in similar undertakings, the Editor begs to renew the expression, given in the Preface to the First Volume, of his sincere thanks to the distinguished surgeons, both in Europe and in his own country, who have toiled with him in the preparation of the Encyclopædia, and to whose cheerfully rendered collaboration is due the great success which the work has obtained. To the Publishers too, and to the numerous subscribers to the work, he owes thanks for the patient indulgence which they have extended to him in regard to the unavoidable delays which have attended the appearance of the several volumes.

JOHN ASHHURST, JR.

PHILADELPHIA,
2000 WEST DELANCEY PLACE,
March, 1886.

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OF THE

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THE INTERNATIONAL

ENCYCLOPÆDIA OF SURGERY.

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BY

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URINARY CALCULUS.

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INJURIES AND DISEASES OF THE URETHRA.

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INJURIES AND DISEASES OF THE MALE GENITAL ORGANS.

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INJURIES AND DISEASES OF THE FEMALE GENITALS.

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OVARIAN AND UTERINE TUMORS.

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INFLAMMATORY AFFECTIONS OF THE BONES.

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SCROFULO-TUBERCULOUS AND OTHER STRUCTURAL DISEASES OF BONES.

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TUMORS OF THE BONES.

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ORTHOPÆDIC SURGERY: THE TREATMENT OF DEFORMITIES.

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By

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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

INJURIES AND DISEASES OF THE ŒSOPHAGUS.

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WOUNDS AND RUPTURES OF THE ŒSOPHAGUS.

WOUNDS OF THE ŒSOPHAGUS.—The whole of the œsophagus is so well protected from ordinary injury that unintentional wounds of any portion of the healthy organ are quite rare. They occur in the usual varieties of contused, incised, punctured, lacerated, and gunshot wounds. They may be superficial or penetrating. They may interest the cervical or the thoracic portion of the œsophagus. Wounds in the thoracic portion are almost exclusively punctured or lacerated in character, the depth of that portion of the organ greatly protecting it from contused and incised wounds. The lesion may be produced by an injury from without or by an injury from within. Wounds from without occur most frequently as the result of military encounters, duels, attempts at assassination, or attempts at suicide. Wounds from within are produced most frequently by pointed, sharp, or jagged foreign bodies impacted in the tube. In several cases severe wounds have been received by jugglers in the feat of sword-swallowing. Wounds from without are most frequently associated with wounds of the air-passages, lungs, or great cervical bloodvessels. For anatomical reasons they are much more frequent in the cervical than in the thoracic portion of the œsophagus. Wounds from within are more frequently isolated than associated with wounds of other structures. Nevertheless, the peculiarity of circumstance may produce an unusual complication, as in the cases of three sword-swallowers. The one violently pushed the blunt end of his sword past an obstacle felt in his œsophagus, and it penetrated the anterior wall of the gullet and passed into the pericardium. A second pierced the pericardium in an attempt to swallow a long, blunt, juggler's knife.[1] In the third case the weapon broke in the gullet, a portion remaining impacted. Attempts were made to push it into the stomach and to dislodge it by emetics, the result being to cause laceration of the stomach by the point, and of the œsophagus by the jagged end of the fragment.[2] Wounds or other injuries of the aorta or other great vessels, of the pleura, lungs, trachea, or bronchi, sometimes occur as sequelæ of internal wounds of the œsophagus, originally isolated.

Wounds from without.—Apart from the operative, incised wounds of œsophagotomy and œsophagostomy, incised wounds of the œsophagus—transverse, longitudinal, triangular, and irregular—have been produced by suicidal and murderous cuts, by cuts from weapons in the hands of antagonists and assailants, and by cuts from the surgical knife in awkward attempts at tracheotomy, whether in one stroke or by dissection. Punctured wounds have been due to the points of swords, bayonets, foils, and daggers, and to the horn of the ox.[3] Lacerated and gunshot wounds have been chiefly due to injuries by missiles discharged from fire-arms large or small. As illustrating the rarity of wounds of the œsophagus from external injury without involvement of the air-passages, a special investigation by Horteloup[4] elicited but four recorded examples.[5] Incised wounds of the œsophagus associated with wounds of the air-passages[6] are more common, especially in cases of cut-throat; but many examples cited in that connection are in reality wounds of the pharynx, that cavity having been entered above the level of the anterior wall of the gullet. Incised wounds may be longitudinal, oblique, or transverse. Transverse or nearly transverse wounds sometimes implicate almost the entire circumference of the œsophagus, and occasionally sever the tube completely.[7] Punctured, lacerated, and gunshot wounds present the physical features common to such injuries. Punctured wounds sometimes penetrate both walls of the œsophagus.

Wounds of internal origin occur in the varieties of incised, punctured, and lacerated wounds. They may be intentional, as in the operations for internal œsophagotomy. They may be traumatic in origin, or the result of pathological processes, or they may be of combined origin. Accidental wounds are most frequently caused by sharp-pointed or irregular foreign bodies, such as nails, spicula of bone, dental plates, and the like; but are sometimes the result of injury by weapons introduced accidentally or voluntarily.

Punctured wounds may interest either the anterior or the posterior wall. The posterior wall has been penetrated by the point of a foil[8] which entered the mouth and lacerated the soft palate. The patient recovered.[9] The anterior wall has been penetrated by the point of the sword of a sword-swallower, the pericardium having been pierced as well.[10] Lacerated wounds may be produced by missiles from fire-arms, by jagged foreign bodies, by incautious use of instruments for exploration and for extraction, by articles inserted for juggling or for suicidal purposes, and by severe efforts at vomiting in subjects with diseases of the œsophagus, or with impacted foreign bodies.[1]

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[1] Parkes, Trans. Path. Soc. Lond., 1848–9. A case of Dr. A. T. Thompson's, cited by Walshe (Diseases of the Lungs, Heart, and Aorta, 2d ed., p. 201. London, 1854).

[2] Gussenbauer, Wien. med. Blätter, 20 und 27 Dec. 1883; London Medical Record, April, 1884, p. 151.

[3] Case cited by Knott (Pathology of Œsophagus, p. 151. Dublin, 1878); Dr. W. D. Hartman, of West Chester, Pa., records a case of punctured wound of the œsophagus from the horn of a wild bullock. (Medical World, May, 1885, p. 171.)

[4] Plaies du Larynx, de la Trachée, et de l'Œsophage. Paris, 1869.

[5] Larrey, Clinique Chirurgicale, t. ii. p. 158. Paris, 1829 (in this instance the lung was wounded); Payen, case narrated by Boyer (Traité des Maladies Chirurgicales, t. vii. p. 279. Paris, 1831); Dupuytren, Blessures par Armes de Guerre, t. ii. p. 334.

[6] Paré, Œuvres Complètes (édition de Malgaigne), t. ii. p. 93. Paris, 1840.

[7] Paré, op. cit.

[8] Levillain, Journ. Univ. de Méd., p. 238, 1820; cited by Mondière (Arch. Gén. de Méd., 2e Série, t. ii.), and by Mackenzie (Manual of Diseases of the Throat and Nose, vol. ii. p. 183. London, 1884).

[9] A nearly similar case, recorded by Wilmer (Cases and Remarks on Surgery, p. 86) and cited by Knott (op. cit., p. 149, Dublin, 1778), terminated fatally.

[10] Parkes, loc. cit.; Walshe, op. cit. (Dr. A. T. Thompson's case, already referred to.)

The pleural sac, the pericardium, and even denser tissues are sometimes lacerated. Thus an instance of fracture of the fourth rib at the vertebral articulation is reported, in the case of an insane patient who introduced the handle of an explosive toy into the œsophagus.[2] When the walls of the gullet are diseased, perforations or lacerated wounds are sometimes made with bougies and stomach tubes.[3] Whether preceded or not by contused, punctured, or lacerated wounds, ulcerations of the walls of the œsophagus may result from inflammation set up by impacted or incarcerated foreign bodies. As a consequence, there may be penetration into the mediastinum, the trachea or bronchi, the pleura or lung, the aorta or other great bloodvessel, the pericardium, or even the heart.[4] Indeed, a case has been recorded in which a fish bone had passed through the intervertebral substance of an infant, and had wounded the spinal cord;[5] and one in which caries of the cervical spine was produced by a nail which had penetrated the œsophagus.[6]

Symptoms of Œsophageal Wounds.—In *penetrating wounds from without*, the symptoms in their totality comprise pain in the region of the œsophagus or stomach, or in the direction of the wound through the neck and thorax, with nervousness, anxiety, dyspnœa, hiccough, thirst, and, if there be an opening at all large, external escape of air, mucus, blood, food, and drink. There may, however, be no characteristic symptoms whatever, and the nature of the lesion may remain unrevealed until examination after death.[7] The special symptoms of contused wounds are said to be pain in swallowing, tumefaction of the overlying tissues, sometimes to such a degree as to impede deglutition and even respiration, with probably symptoms at a later period of suppurative inflammation and abscess. The symptoms of *wounds from within* comprise pain, cough, and dyspnœa, and the vomiting of mucus, blood, and food. *Penetrating wounds* produce additional symptoms. Thus, penetration into the mediastinum will occasion symptoms of collapse, and subsequently of suppurative inflammation of the connective tissue, and perhaps of pneumonia; penetration of the pleura will give rise to pleuritis with probable empyema, to pneumothorax, or to pneumonia; penetration of the pericardium, to pericarditis; of the bloodvessels, to hemorrhage; of the trachea or bronchi, to cough and expectoration of blood, mucus, saliva, and food.

Diagnosis.—The history of the accident, the location and direction of the external wound, and the external escape of mucus, blood, saliva, food, or drink, will indicate the nature of the lesion in most instances of wound from without. It must be thoroughly ascertained, however, that such matters do not emerge from a wounded larynx or trachea. There may not be any escape of food passing along the œsophagus, and then the diagnosis cannot be made.[8] It is believed that minute punctured wounds often elude detection in this way.[9] Hæmatemesis, however, following a penetrating wound of the neck or of the thorax, should be regarded as an indication of wound of the œsophagus. Superficial external wounds, giving rise to no characteristic symptoms, are difficult of diagnosis. Longitudinal penetrating wounds may elude detection when their edges remain in contact. Gaping transverse wounds speak for themselves. Violent thirst[1] and continuous hiccough[2] are said to be especially significant of wounds of the œsophagus. Contused wounds are difficult of diagnosis. Their existence is inferred from the evidence of serious injury of the overlying parts, coexisting with pain in the œsophagus, and with dysphagia and hiccough. In wounds from within, the diagnosis will depend on the history of a foreign body, the presence of blood in matters vomited or regurgitated, dysphagia, thirst, and localized pain.

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[1] Gussenbauer, case cited by Carpenter (Medical News, July 7, 1883, p. 25). A broken blade in the œsophagus of a sword-swallower.

[2] Guise, case cited by Horteloup (op. cit., p. 24).

[3] Shaun, Brit. Med. Jour., Nov. 3, 1873.

[4] Andrew, Lancet, 1860.

[5] Mackenzie, op. cit., vol. ii. p. 192.

[6] Steven, Brit. Med. Jour., Dec. 10, 1870.

[7] Dupuytren, case cited by Horteloup (op. cit.).

[8] Dupuytren's case already cited.

[9] Horteloup, op. cit., p. 19.

Prognosis.—The natural history of operative wounds of the œsophagus, in both external and internal œsophagotomy, indicates that but little danger is to be apprehended from a clean-cut longitudinal wound implicating no other important structure. Cicatrization may be expected in from five to eight days. Punctured wounds, and minute incised wounds, may be expected to unite in from three to four days. The arrangement of the muscular fibres of the œsophagus, in longitudinal and circular layers, favors muscular contraction in wounds of this character.[3] Transverse wounds present a much graver prognosis on account of the greater liability that matters may escape from the œsophagus into the surrounding tissues, and thereby induce death by suffocation or by inflammatory processes. The edges of a transverse wound may be so widely separated as to preclude the possibility of approximation,[4] especially when the organ has been severed in its entire circumference. Even after recovery from such a complete severance, the edges of the resulting fistula may remain so wide asunder as to necessitate permanent alimentation by means of a tube passed through the opening.[5] The same result follows lacerated bullet wounds,[6] or other wounds which have destroyed integral portions of the œsophageal walls. The prospect is much the best in wounds from without, when the wound is slight, longitudinal in direction, situated high up, and unassociated with wounds of the air-tubes or of the great bloodvessels. Suicidal wounds implicating the bloodvessels are usually fatal by hemorrhage. When not immediately fatal, such wounds render the prognosis graver on account of the consequent debility produced by the hemorrhage. Wounds in the thoracic portion of the œsophagus are so inaccessible to surgical manipulation that the prognosis is rendered very grave indeed. In an undetailed mention by Mondière of five personal observations[7] of wounds in this region, recovery is reported in but one instance.

Recovery from incised wounds of suicidal origin is not infrequent. Small punctured wounds are said to cicatrize spontaneously with great rapidity.[8] Recovery has ensued from a severe bayonet wound[9] in which the weapon had passed between the third and fourth ribs, wounding the lung, of course, in its transit.

The prognosis does not seem to be particularly grave in gunshot wounds, even though the air-passage be implicated. In the tabular statement of a series of gunshot wounds of the neck occurring in the United States,[10] it is to be noted that there were eight cases of wound injuring the œsophagus without injury to the air passages, with four recoveries; two cases of wound injuring the trachea and œsophagus, both fatal; one case of wound injuring the cricoid cartilage and œsophagus, with recovery;[1] and one case of wound involving the pharynx and œsophagus, likewise with recovery. Internal hemorrhage is given as the cause of death in one case of penetrating wound of the œsophagus. In the case of recovery after wound of the pharynx and œsophagus, loss of voice, difficulty of breathing, and constant cough, were noted as sequelæ present seven years after receipt of the injury. A buckshot was still in the left side of the neck at the date of report. In the case of recovery after a penetrating wound of the cricoid cartilage, partial aphonia was noted as existing a few days before the patient was returned to duty. Cough, dyspnœa, and impairment of voice, therefore, are liable to be produced in injuries of this kind which may immediately or subsequently compromise the integrity of the fibres of the pneumogastric and inferior laryngeal nerves.

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[1] Larrey, Clinique Chirurgicale, t. ii. p. 155. Paris, 1829.

[2] Mondière, loc. cit.

[3] Larrey, op. cit., t. ii. p. 157.

[4] Paré, op. cit.

[5] Trion, case cited by Boulin (Sur les Plaies de l'Œsophage, p. 15. Thèse de Paris, 1828), and by Knott (op. cit., p. 150); Henschen, Upsala Läkareforenings Förhandlingar, 1874, and London Med. Record, August 16, 1875.

[6] Mondière, op. cit.

[7] Ibid.

[8] Boulin, op. cit., p. 19.

[9] Payen, case reported by Boyer (op. cit., t. vii. p. 279); cited by Boulin (op. cit., p. 15); by Nélaton (Élements de Pathologie Chirurgicale, t. iii. p. 477. Paris, 1854); by Horteloup (op. cit.); and by others.

[10] Medical and Surgical History of the War of the Rebellion, Part III.; Surgical Volume, p. 688. Washington, 1883.

Other recoveries have been noted in gunshot wounds, both in military[2] and in civil practice.[3]

The difficulty of obtaining nourishment in a case of external wound of the œsophagus, may be so great as to exhaust the strength in a short time. Death has been recorded at thirty-six hours,[4] but it is more frequent after the lapse of several days.[5] A patient died suffocated and in convulsions on the seventh day, in a case which had been progressing favorably, the cause being the unauthorized deglutition of large morsels of bread and meat, and of a quantity of wine, which forced open a cicatrizing wound, so that large quantities of wine and water, and some of the solid food, escaped into the thoracic cavity.[6]

In *wounds from within*, the prognosis will depend upon the character of the lesion in the œsophagus, and upon that of any accompanying lesions, primary or consecutive. Lacerated wounds are likely to be much more superficial than punctured or incised wounds, and thus offer a favorable prognosis upon withdrawal of the foreign body, provided that the wound has not been extensive. Punctured wounds are much less favorable. They are sometimes associated with punctured wounds of large bloodvessels, and are thus rendered especially serious. Death by hemorrhage may ensue from an internal wound by any sharp or pointed body, even a bone.[7] Perforating wounds are not infrequently fatal, whether produced by stomach tube,[8] bougie, or impacted foreign body—such as a dental plate[9] or bone—even although there may not have been any evidence of its impaction.[10]

Penetration into the mediastinum, with the escape of fluids, is indicated by collapse, and is almost necessarily fatal. The same grave prognosis may be pronounced in cases of penetration into pericardium, pleura, lung, or air-passages, death being imminent from suffocation, or as the result of inflammatory and eventually of suppurative processes set up in the invaded tissues.

Treatment.—The treatment of wounds of the œsophagus must be conducted on the general principles of surgery, adapted to the requirements of the individual case. In wounds of external origin it is allowable, if not actually desirable, to unite the edges of the wound by suture, if the edges can be kept properly approximated. This is quite easy in accessible longitudinal wounds, in which, according to experiments on dogs[11] and the results after œsophagotomy, union may be expected from the fifth to the eighth day.

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[1] Ibid., Part I., Surgical Volume, p. 408. Washington, 1870.

[2] Baudens, case cited by Knott (op. cit., p. 152); Mondière, op. cit.; Horteloup, op. cit., p. 24.

[3] Charles, Brit. Med. Journ., March 31, 1883.

[4] Étienne, Considérations Générales sur les Causes qui gênent ou empêchent la Déglutition, p. 8. Thèse de Paris, 1806; cited by Mackenzie (op. cit., vol. ii. p. 183).

[5] In Dupuytren's case, due to a stab, death occurred on the seventh day.

[6] Larrey, op. cit., t. ii. p. 162.

[7] Annandale, Edinburgh Med. Journ., April, 1872.

[8] Gaz. Hebd., 26 Sept. 1873; Phila. Med. Times, Oct. 25, 1873.

[9] Smith, New York Med. Times, Sept. 1873.

[10] Shaun, Brit. Med. Journ., Nov. 3, 1873.

[11] Guattani, Mém. de l'Acad. de Chir., t. iii. p. 351; Jobert, case cited by Boulin (op. cit., p. 18).

Interrupted sutures should be used, and their ends should be cut close off, so that the thread may find its way into the interior of the tube and be discharged with the contents of the bowel. In some cases, however, it may be requisite to avoid sutures, in order that the opening may be kept patulous for the introduction of a tube through which nourishment can be injected. In case of transverse wounds, whether sutured or not, the head should be bound down towards the chest,[1] to favor cicatrization.

If the wound be closed by suture, attempts may be made at once to supply nourishment by the mouth. Should the wound be allowed to cicatrize without interference, it is deemed allowable to begin cautious administration of nourishment by the mouth as soon as cicatrization in its entire extent begins to be steadily progressive, say after the fifth or sixth day in longitudinal and in small transverse and punctured wounds. Under either condition, food should not be administered at first in larger quantities than a teaspoonful or so at a time. Should any food escape by the wound under either condition, resort must be had to rectal alimentation until such escape is no longer imminent. The use of tubes passed through the mouth is generally considered injurious, whether employed shortly after the receipt of the injury, when cough and retching may enlarge the wound, or after cicatrization has begun, when the same effects may reopen it.[2] Meanwhile, thirst is to be allayed, as well as may be, by injecting water into the rectum, by periodically sponging the surface of the body, and by moistening the lips, tongue, and gums at frequent intervals with cold water, simple or acidulated, with the juice of oranges or other fruits, with effervescing lozenges, or with pellets of ice. Cold, emollient baths, and continuous cataplasms over the stomach, have been highly recommended for the same purpose.[3] Great care is necessary in returning to ordinary diet, lest the cicatrix suffer rupture, a condition under which food may escape into the thoracic cavity.[4]

It does not appear that stricture of the œsophagus is a likely sequel to a wound. Fistulæ, however, sometimes remain. They are said to heal promptly under pressure aided by mild stimulation of their edges with the actual cautery,[5] solid silver nitrate, or cupric sulphate. Plastic operations are not deemed advisable.

In the treatment of wounds from within, neither solid food nor liquid should be allowed by the mouth until several days have elapsed. Then fluids may be cautiously administered in gradually increasing quantities, the return to ordinary diet being quite gradual. Meanwhile, supplementary nourishment should be supplied by enemata. Thirst is to be allayed by enemata, by fragments of ice in the mouth, and by periodical sponging of the body; and pain is to be subdued by the administration of anodynes, subcutaneously or by the rectum. The constitutional manifestations in all varieties of wounds are to be met on general therapeutic principles.

Rupture of the Œsophagus.—Rupture of the œsophagus is an accident of rare occurrence. It takes place during violent retching and vomiting, usually during a hearty meal or after it. Thirteen cases tabulated by Mackenzie,[6] and one since reported by Purslow,[7] probably comprise the entire record. The rupture is most apt to take place just above the diaphragm. It may take place as low down as the cardia, however, and may even extend into the stomach.[8] The rent is usually longitudinal, only a single example of transverse rupture[1] being on record. The length of the tear in recorded cases varied from half a centimetre to five centimetres. The mucous coat often suffers to a greater extent than the muscular and fibrous coats. The edges are usually clean cut. In six out of the fourteen cases alluded to, the left pleura was opened, and in one[2] of these the diaphragm was ruptured in addition. The contents of the œsophagus, food and blood, may be discharged into the pleura when that cavity is penetrated; otherwise they are discharged into the mediastinum.

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[1] See Vol. V. p. 642, *supra.*

[2] Cooper, Lectures on Surgery, vol. ii.

[3] Larrey: op. cit., p. 156.

[4] Larrey, case cited.

[5] Baudens's case, already cited.

[6] Op. cit., vol. ii. p. 178.

[7] British Med. Journ., March 28, 1885, p. 658 (an infant aged eleven months).

[8] Grammatzki, Ueber die Rupturen der Speiseröhre. Königsberg, 1867; cited by Mackenzie.

The immediate *cause* of rupture is violent vomiting, when the stomach is well filled, whether the vomiting be spontaneous or produced by emetics. In two instances it has followed voluntary efforts to dislodge a foreign body. Although the healthy œsophagus has occasionally undergone rupture,[3] the accident usually occurs in the diseased organ, and especially in intemperate subjects.[4]

Symptoms.—The symptoms are sudden acute pain in the œsophageal region during vomiting, with the sense of something having given way inside, hæmatemesis, great distress and anxiety, emphysema of the neck, and rapid collapse from the shock. The emphysema may extend beyond the neck, over the trunk, and even over the greater portion of the body.

Diagnosis.—This seems to be very obscure despite the characteristic features of the symptoms, the nature of the lesion having been but once recognized during life.[5]

Prognosis.—The prognosis is unfavorable. The patients die within a few hours from collapse, usually in from four to eighteen hours. One patient has been known to survive twenty-four hours, one fifty hours, and one seven days and a half.[6]

Treatment.—The fatal character of the accident shows that treatment is useless, except to relieve suffering. Rectal alimentation and stimulation seem indicated, with the hypodermic use of anodynes and diffusible stimulants, and the local use of ice to relieve thirst. The body and the injured organ should be kept as completely at rest as possible.

Foreign Bodies in the Œsophagus.

Foreign bodies often become temporarily lodged in the œsophagus, and frequently become impacted in the organ; usually singly, sometimes in numbers. Although in most instances the result of accident in deglutition, the lodgment may be intentional, whether the foreign body be introduced in jugglery; or swallowed in concealment of coins, jewels, or dispatches; or inserted or swallowed as a means of suicide. Matters which are vomited occasionally become lodged in the œsophagus, and, exceptionally, missiles from firearms.

The objects most frequently lodged in the œsophagus are alimentary boluses, chiefly fragments of bone, of meat, or of vegetable, masticated or unmasticated, which have been swallowed inadvertently, and often matters swallowed in masses too large for descent by ordinary peristalsis. Extraneous bodies of the most varied character have become lodged in the œsophagus, such as coins, fish-hooks, pins, tacks, nails, blades, knives, forks, spoons, keys and key-rings, beads, sponges, dental plates with false teeth, palate-obturators, seat-worms, tapeworms, round worms, leeches, living fish, detached carious bones,[1] hydatid cysts, and what not.

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[1] Boerhaave's case.

[2] Williams, Trans. Path. Soc. London, vol. i. p. 151.

[3] Boerhaave, Van Swieten's Commentaries, vol. ii. p. 102. Edinburgh, 1786; Oppolzer, Vorlesungen über specielle Pathologie und Therapie, Bd. ii. Lief. 1, S. 151. Erlangen, 1872; Fitz, Am. Jour. Med. Sciences, Jan. 1877.

[4] Charles, Dublin Jour. Med. Sci., p. 311, Nov. 1870. Cites in addition Dryden, Medical Commentaries, vol. ii. Decade 2, 1788, and gives several other references.

[5] Meyer, Med. Vereinszeitung v. Preussen. Nos. 39, 40, und 41. 1858; cited by Mackenzie.

[6] Fitz, case of Allen (Am. Jour. Med. Sci., Jan. 1877, p. 17).

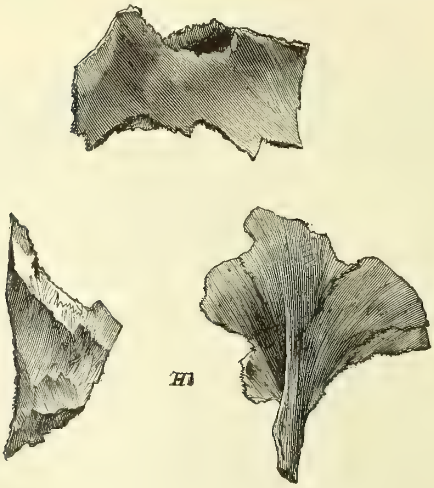
The subjoined table, from Poulet,[2] with a few additions, shows the varieties of foreign body which have been encountered in the œsophagus:—

TABLE OF FOREIGN BODIES IN THE ŒSOPHAGUS.

Animate		Leeches, fishes, salamanders, mice, eels, frogs, ascarides lumbricoides, tæniæ, hydatids.
Inanimate	Organic	Beef-bones, fish-bones, other food bones, nasal bones, vertebral sequestra, pieces of meat and vegetable, fruits and kernels, potato, pieces of wood and grain, lung, egg, hair, cork, comb, sponge, spindle, dominoes, violin-pegs, comfits, cake, flute-stopper, teeth, dental plates, masses of rags, feathers, tobacco.
	Inorganic	Pins, needles, pens, coins, flat and round bodies (child's saucer, medals), toys, dental plates, artificial teeth (metallic), palate-obturator, knives, scissors, compass, razors, blades, sword-blades, forks, spoons, rings, buttons, buckles, keys, pebbles, glass, vials, pieces of stone, brick, thermometers, bullets, bullets from projectiles, bars, pieces of pots, eyeglasses, butchers' hone, iron file, brass chains, lead seals, tubes and pipes, diamonds, table-rollers, sucking bottle, beads, sounds, plaster, padlocks, fish-hooks, barbed wire, meat-skewers, tin tag from tobacco.

Irregular fragments of bone (Fig. 1161) may be regarded as the most likely substances to become impacted in the œsophagus. Theoretically, certain conditions predispose to the lodgment of foreign bodies in the gullet. Among these may be especially enumerated loss of teeth; paralysis and spasm of the muscles of the face and lips, or of the tongue, palate, pharynx, and œsophagus; inflammatory affections and neoplasms of the mouth, tonsils, pharynx, œsophagus, epiglottis, larynx, and neck; enlarged cervical glands; goitre; strictures and organic degenerations of the œsophagus. The accident is sometimes due to imperfect cooking of food, or to failure to remove fragments of bone from soups, stews, and other dishes. False teeth sometimes become detached in sleep, dislodged in eating, or dislodged while the individual is under the influence of an anæsthetic, and under all of these conditions have entered the œsophagus and become impacted there.

Fig. 1161.



Specimens of irregular fragments of bone lodged in the œsophagus. Natural size. Museum of Val-de-Grace. (After Poulet.)

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[1] Langenbeck, Memorabilien, Heft 1, 1877; New York Med. Journ., July, 1877, p. 99.
[2] Op. cit., vol. i. p. 71.

In patients with stricture of the œsophagus, want of care in swallowing only proper morsels of food, or carelessness in putting improper things into the mouth, will give rise to the accident. Impaction is the more serious by reason of the stricture.[1]

Points of Lodgment.—There being three anatomical regions at which the calibre of the œsophagus is normally smaller than elsewhere, there are that many points at which lodgment is the more likely to take place. These points are: (1) at the pharyngeal extremity of the tube: (2) at the point where the œsophagus is crossed by the left primitive bronchus; and (3) at the point where it passes through the opening in the diaphragm, just above the expansion into the cardiac extremity. Spiculated and irregularly shaped substances are apt to become entangled or partially imbedded in the mucous membrane, and may become impacted at any portion of the œsophagus.

Effects, Immediate and Consecutive.—Sudden death by suffocation may ensue by compression of the trachea, by blocking the outlet of the air-passages when the foreign body is partly lodged in the pharynx, or by spasm of the glottis, due to irritation. Death occurring in this manner has sometimes been mistaken for death by cerebral apoplexy. Laceration by jagged objects may produce hæmatemesis. Prolonged detention of a foreign body may sometimes result in dilatation of the œsophagus, annular or sacculated. Sometimes the foreign body becomes permanently lodged in the diverticulum.[2]

Foreign bodies sometimes remain for years in the œsophagus and cause comparatively little suffering. Sometimes, as with needles and pins, they work their way in safety through the different tissues to the surface of the body, even to the most unlikely regions.[3]

In some instances, when unheard of, they probably become encysted. In others they occasion abscesses at various portions of the surface, with the contents of which they are discharged, or through the openings of which they are extracted. They may escape through an abscess of the neck.[4] Sometimes an œsophageal abscess, due to inflammation excited by a foreign body, communicates with the trachea, the bronchi, the pleura, the lung, the mediastinum, or the pericardium.

Indigestible foreign bodies, propelled into the stomach, most frequently pass through the intestinal tract and are discharged by defecation. Some of them excite ulceration in the stomach, or in some portion of the intestine, and are discharged through an abscess bursting at the exterior of the body. They may thus escape at the epigastrium,[5] at the extremity of the rectum, or elsewhere.

In the valuable memoir of Hévin,[6] an instance is related in which three different substances, swallowed by the same individual, emerged through as many abscesses, at the right and left hypochondria, and at the lumbar region, respectively.

Fish-bones are liable to produce serious multiple lesions. Thus, sudden death has been reported in a case of impaction in the œsophagus of a fish-bone which penetrated the stomach, the diaphragm, the pericardium, the posterior surface of the heart, the interventricular septum, and the left coronary vein;[7] and of a fish-bone which penetrated the œsophagus, diaphragm, and pericardium, and wounded the surface of the left ventricle.[8] Wound of the spinal cord[1] has been discovered, after death, to have been due to penetration by a fish-bone through the intervertebral substance.

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[1] Menzel, Arch. f. klin. Chir., Bd. xiii. S. 678. 1872; Brit. Med. Journ., Aug. 31, 1872, p. 243.

[2] Monti, Jahrb. für Kinderheilkunde, 20 Oct. 1875.

[3] Cohen, Diseases of the Throat, etc., p. 319. New York, 1879.

[4] Fortuné, case cited by Poulet.

[5] Cripps, Brit. Med. Journ., March 22, 1884, p. 561.

[6] Mémoire sur les corps étrangers de l'œsophage. Paris, 1743; Mémoires de l'Academie Royale de Chirurgie, t. i. p. 561. Paris, 1761.

[7] Andrews, Lancet, Aug. 25, 1860, p. 186.

[8] Eve, Brit. Med. Journ., April 3, 1880, p. 517.

Symptoms.—The immediate symptoms, varying with the nature of the foreign substance, the position it occupies, and the condition of the œsophagus, are insignificant in some instances, and markedly characteristic in others. Sometimes large coins, bones, and other bodies remain impacted in such a position as to give no evidence of their presence, until sudden death by hemorrhage leads to a post-mortem examination, which reveals erosion into the aorta[2] or some other important vessel.[3] The immediate symptoms comprise in their totality: dyspnœa, sometimes suffocative; dysphagia or aphagia; dysphonia or aphonia; pain in the neck, thorax, or stomach; nervousness, dread of death from the accident; spasm of the œsophagus, of the air-passages, or even convulsive or tetanic spasm of the lower jaw and of the extremities; retching, vomiting, expectoration, and hemorrhage. The functional symptoms usually cease upon spontaneous expulsion of the foreign body, or upon its passage into the stomach, or upon its impaction in some portion of the gullet. Subsequent to the sensory and spasmodic symptoms, others are developed, in cases of long or permanent retention, indicative of inflammation, suppuration, ulceration, and perforation of the œsophagus. Finally, there may be insomnia, innutrition, pyrexia, marasmus, hectic, and death by asthenia. Certain nervous symptoms sometimes remain after expulsion of the foreign body, the result of its previous pressure, and torment the patient with fears that another foreign body is lodged in the œsophagus.

A small, smooth substance may produce only a vague sense of discomfort, indicative of its detention in some defined or undefined portion of the œsophagus. The sensations of patients are not reliable guides to the locations of foreign bodies. A large body provokes retching, and is often ejected thereby, especially when of some regular form. Spiculated bodies become sometimes nailed, as it were, to the mucous membrane by the act of vomiting. A pin, tack, knife-blade, or the like, will be apt to give rise to sensations of pricking, and sometimes will occasion hemorrhage. Large bodies present a mechanical obstacle to the passage of solid food, and sharp ones produce pain in deglutition. When respiration is mechanically impeded, the dyspnœa is usually greater in inspiration; when disturbed by nervous influence, the dyspnœa is usually equally manifested in expiration also.

Diagnosis.—The first element in the diagnosis is the history preceding the immediate symptoms. This may be wanting in children, lunatics, and determined suicides. Inspection through the mouth is rarely of service, even though an œsophagoscope be employed. With the aid of œsophagoscopy, however, a small, flat piece of bone has been discovered two inches below the cricoid cartilage, on the anterior wall of the œsophagus.[4] External palpation sometimes detects an impacted body high up.

Large bodies sometimes cause sufficient projection in the left cervical region to attract attention by the deformity which they produce. Stability of position is almost invariable. In cases of fancied bodies in the œsophagus, the alleged position of the obstacle is usually varied from time to time. Digital exploration through the mouth, if the finger be long enough, is sometimes sufficient to detect a foreign body lodged high up. Care must be taken not to mistake the tense edge of the pharyngo-epiglottic ligament for the edge of a fish-bone, needle, pin, or other substance. Palpation with a sound, catheter, or bougie is usually requisite to detect the position of the foreign body, and to determine its density, if unknown. This manipulation, however, is not always practicable. One of the best appliances for this purpose is the sound of Langenbeck: a flexible, whalebone rod, tipped with a smooth, polished, metallic knob. The knob as it strikes a hard foreign body produces a click. The sounds most in use have ivory knobs. Knobs of varying sizes should be supplied with each rod, firmly attachable by a screw. A special resonator has been devised by Duplay, and perfected by Collin, provided with a sounding-box and an ear-tube (Fig. 1162); but such an instrument of precision can rarely be required, although an instance has been recorded in which it permitted the recognition of a coin which could not be otherwise detected. Any instrument used in exploration should be marked in a graduated scale, so as to indicate the precise relations of a foreign body with the walls of the œsophagus. The sound, when possible, should be carried to the stomach. If no obstacle be encountered, it may be inferred, as a rule, that the foreign body has passed into the stomach, though the inference is not always reliable. The most careful sounding will sometimes fail to detect the presence of a foreign body known to be in the œsophagus. Collections of mucus or of moist food around the foreign body, may cause the searcher to slip past it without detection. If the foreign body be of such a shape as to become closely applied to the wall of the œsophagus, the sound may slip by without encountering it.[1] Fragments of bone may escape detection in this manner.[2]

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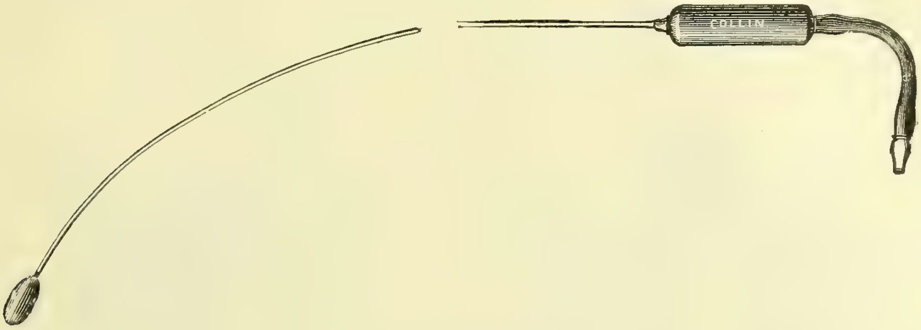
[1] Mackenzie, op. cit., vol. ii. p. 192.
[2] Bégin, case cited by Poulet (op. cit., vol. i. p. 75).
[3] Erichsen, Science and Art of Surgery, vol. i. p 189.
[4] Mackenzie, op. cit., vol. ii. p. 193.

Fig. 1162.



Duplay's resonator.

In a case in which the fragment of a sword, broken off in the œsophagus, could not be detected in the gullet of a juggler, it was found, upon post-mortem examination after gastrotomy, that the fragment had become concealed behind a fold of injured membrane in which it had become caught, probably during vomiting in attempts at expulsion by emesis.[3] Should exploration of the œsophagus be impracticable without anæsthesia, the manipulations must be made with the patient recumbent. This is readily done by supporting the head a little below the level of the table or couch upon which the patient lies, thus bringing mouth, pharynx, and œsophagus into the same plane. Under other circumstances, the exploration is best made with the patient in the sitting posture, the head being well thrown back so as to bring the axis of the mouth and pharynx as nearly as practicable in a direct line with that of the œsophagus. The mistake is sometimes made of attributing dyspnœa to the presence of a foreign body in the air-passage, under which circumstances a fruitless tracheotomy has been occasionally performed, when the foreign body has been detected in the œsophagus on examination after death.[1] Careful exploration of the œsophagus during life should prevent such a mistake. It is possible, also, that late symptoms of suffocation may be attributed wholly to prolonged disease of the air-passages, when really due to compression by a foreign body in the gullet.[2]

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[1] Case of English half-penny applied against anterior wall. Marston, Brit. Med. Journ., March 4, 1882, p. 305. (Welch's case.)

[2] Legouest, case cited by Michel (Dict. Encyclopédique des Sciences Médicales, Art. Œsophage, p. 515).

[3] Gussenbauer, Wien. med. Blätter, 20 und 27 Dec. 1883; London Med. Record, April, 1884, p. 151.

Prognosis.—It is only exceptionally that death by suffocation from pressure upon the air-passages ensues before surgical help can be procured. Death by laryngeal spasm[3] sometimes occurs. The prognosis is favorable in the majority of cases in which prompt measures are taken to withdraw or displace the impacted foreign body. Any injury already sustained by the œsophagus, or inflicted upon the organ in the surgeon's manipulations, will serve to render the prognosis proportionately more serious. The patient, having safely passed over the immediate danger, is kept under observation for a few days, during which he is treated on the principles laid down for the management of œsophagitis and wounds of the œsophagus of internal origin, when, if no manifestations of severe injury remain, recovery may be confidently anticipated.

The prognosis is grave in cases of foreign body retained in the œsophagus for more than a few days, although such bodies sometimes remain apparently or actually quiescent for periods varying from days to many months[4] or years. Inflammation, abscess, ulceration, and perforation of the œsophagus and of adjacent structures, are the sequelæ to be apprehended. Death by abscess[5] occurs in some instances. In others, a foreign body makes its way to the exterior through an abscess, leaving a fistula of the œsophagus. More frequently, however, the abscess closes on removal of the foreign body, whether the removal has been spontaneous or operative. Should the abscess or ulceration be located anteriorly, perforation may take place into the trachea, when the escape of the foreign body into the air-tube may be followed by immediate death from suffocation, or by slow death from exhaustion due to the resulting inflammatory processes. Should, however, the foreign body still remain in the œsophagus, a tracheo-œsophageal or broncho-œsophageal fistula will be established, with all the dangers due to a wound of the œsophagus.

Serious hemorrhage may take place when the foreign substance becomes dislodged by ulceration, though, as a rule, recovery is prompt after such dislodgment. Sometimes stricture is produced as a result of cicatrization. Death by hemorrhage may occur in consequence of erosions communicating with the aorta[6] (Fig. 1163), or with other important vessels.[7] Such perforations are not uncommon.[8] They have occurred as early as the third day.[9]

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[1] Cases cited by Desault (Œuvres, t. ii. p. 261); by Poulet; by Roberts (Bryant's Manual for the Practice of Surgery, p. 451. Phila. 1882).

[2] Cauchois, Bull. de la Soc. Anatomique, p. 44, 1872; cited by Poulet.

[3] Bryant (op. cit., p. 451) records an instance in a two-year old child, with a piece of pudding impacted in the œsophagus.

[4] A set of teeth has been ejected fifteen months after the accident (Hayem, case cited by Poulet).

[5] Vanderwarker, New York Med. Jour., April, 1871, p. 453.

[6] Bégin, case cited by Poulet (op. cit., vol. i. p. 75); retention for fourteen days of a six-franc piece at the level of the bifurcation of the bronchi.

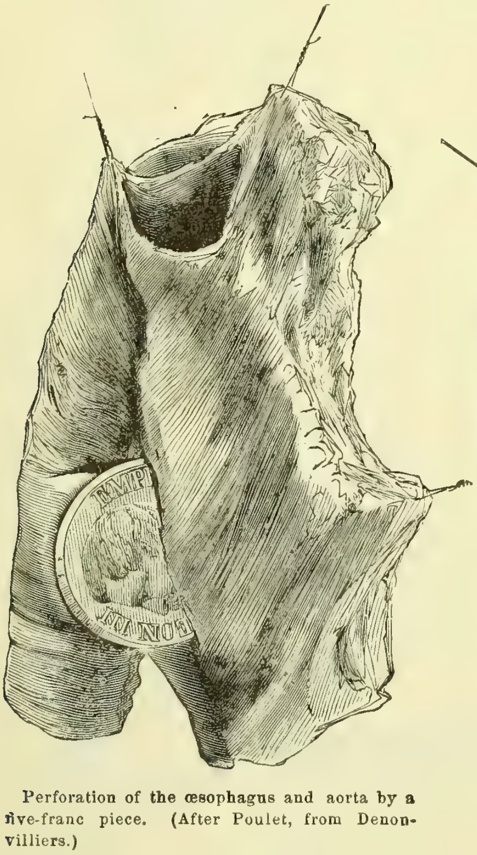
[7] Erichsen, Science and Art of Surgery, vol. i.; piece of gutta percha which had remained imbedded in the œsophagus unsuspected for six months.

[8] Lavacherie, Mémoire sur les corps étrangers de l'œsophage (Mém. de l'Acad. Royale de Méd. de Belgique, 1848); Martin, Corps étrangers de l'œsophage, Thèse de Paris, 1868; Poulet, op. cit., vol. i p. 91; and numbers of individual observations.

[9] Spry, Trans. Path. Soc. Lond., vol. iv. 1853.

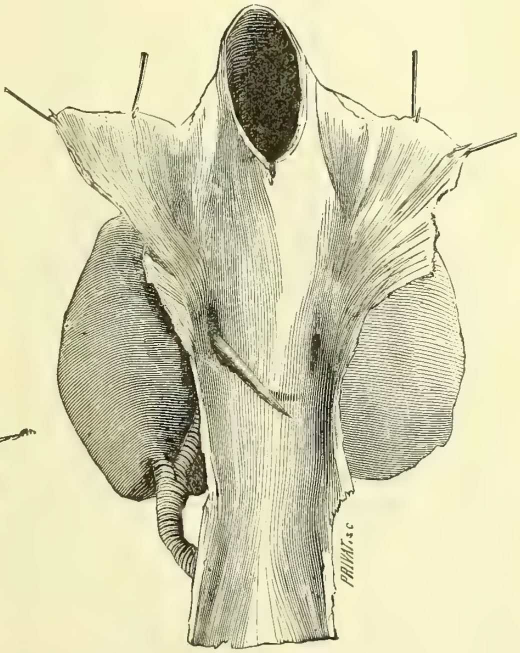
In a compilation of thirty-three instances of slow perforation of bloodvessels by ulceration,[1] it was found that the aorta had been pierced in seventeen, the left carotid in three, the vena cava in two, and the right carotid, the inferior thyroid (Fig. 1164), an abnormal right subclavian, the pulmonary and the œsophageal arteries each in one, undetermined arteries in four, and the right coronary and demi-azygos veins each in one instance. Primary perforation of the bloodvessels is rare;[2] the only two cases collected by the author of the compilation alluded to involved the aorta, and were caused respectively by a pointed bone and a needle,[3] and in both of them death by hemorrhage occurred shortly after the receipt of the injury.

Fig. 1163.



Perforation of the œsophagus and aorta by a five-franc piece. (After Poulet, from Denonvilliers.)

Fig. 1164.



Perforation of inferior thyroid artery by bone. (After Poulet, from Pilate.)

Among other causes of death noted from retained foreign bodies in the œsophagus, may be mentioned eclampsia;[4] purulent œsophagitis,[5] even from so simple an object as a bead;[6] caries of the vertebræ[7] secondary to œsophagitis; disease of the cord consequent upon ulceration of the intervertebral substance,[1] or wound of the cord from penetration through the same;[2] and ulceration of the pericardium with fatal pericarditis.[3] Should it be impossible to remove a foreign body, or should a foreign body remain undetected, death may take place by starvation, the patient perhaps dying in delirium.[4]

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[1] Poulet, op. cit.

[2] Collins, Dublin Quart. Jour. Med. Sci., vol. xix. p. 325. 1855.

[3] Lancet, vol. ii. p. 789. 1877.

[4] Larrey, Clinique Chirurgicale, t. ii. p. 164. Paris, 1829; Mayer, Deutsch Arch. für klin. Med., Bd. xvii. S. 121 (cited by Poulet).

[5] Gussenbauer, Wien. med. Woch., S. 20. 1876; ten days after œsophagotomy and removal of a large, bent table-knife.

[6] Billroth, Clinical Surgery, p. 132. London, 1881.

[7] A case in the Journal Général de Médecine, etc., t. xiii. 1807 (cited by Poulet); Mondière, Arch. Gén. de Méd., 1830; Galais, Gaz. des Hôp. No. 20. 1864; Arch. f. klin. Chir., Bd. viii. S. 482; Steven, Brit. Med. Jour., Dec. 10, 1870, p. 529.

Substances sometimes remain impacted for considerable periods, the patients becoming very much reduced.[5] In some of these instances, the presence of the foreign body is not suspected or has been forgotten, and the patients are treated for paralysis of the œsophagus, for phthisis, and for other disorders usually productive of the special symptoms manifested.

Treatment.—Should expulsion not take place spontaneously, or by the usual methods of relief employed by the sufferer or the bystanders, such as swallowing water or additional solid food, striking the patient on the back, or provoking emesis by titillating the uvula or the pharynx, the services of the surgeon become necessary to dislodge the foreign body or to withdraw it. Should suffocation be threatened, prophylactic tracheotomy would be indicated in advance of attempts at interference with the foreign body. The character of the body and its location, as determined by the fingers or sound, will indicate the special method to be employed. Emesis may be tried in suitable cases. Should swallowing be impracticable, the medicament may be injected through a catheter, if such an instrument can be passed beyond the obstruction;[6] otherwise a hypodermic injection of apomorphine-hydrochlorate, one-tenth of a grain for an adult, may be tried. Emesis is not advisable in the case of sharp or irregular bodies, as it is likely to encourage further impaction, and to drive the points of the body into the mucous membrane or even through the walls of the œsophagus. If a coin or similar substance be lodged high up, it is recommended to lay the individual prone upon a table with the head supported over the edge by an attendant, and then to introduce the finger far enough to drag the base of the tongue forward, in hope that the retching induced will force the substance out of the mouth. Should instrumental aid be requisite, the choice of appliance—hook, forceps, swollen sponge, or snare—will depend on the resources of the surgeon and on the character of the foreign body. Before the instrument is introduced into the gullet, it is well to let the patient swallow a little oil, if he can, or to pour some oil into the œsophagus, as recommended by Langenbeck. The instrument must be warmed, to prevent spasm; and oiled, so as to glide easily. Substances not far from the orifice may be seized with slender curved forceps, several varieties of which are here figured. (Figs. 1165–1168.) These instruments, carefully introduced, are used first as searchers and then as extractors.

Linked or jointed forceps (Fig. 1169) are said to be particularly serviceable. The revolving forceps of Gama (Fig. 1170), and the modification by Bryant,[7] present peculiar facilities for grasping irregular bodies. It is sometimes more feasible to pass a blunt hook or similar contrivance beyond the object, and then draw it back into the pharynx. Petit ingeniously bent a loop of strong silver wire into a blunt hook, and then rolled it for some distance into a spiral twist. (Fig. 1171.) This, or some similar improvised appliance can be readily insinuated beneath favorably located bodies so as to draw them out. Coins may sometimes be readily removed with Graefe's oscillating or swivel-basket coin-catcher (Fig. 1172), or with a rigid coin-catcher of similar construction (Fig. 1173). A number of similar instruments have been devised, but it would serve little purpose to enumerate them. They are pictured in the catalogues of the instrument-makers. A sponge probang, if it can be passed beyond the obstacle, may be left *in situ* for a while,

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[1] Ogle, Trans. Path. Soc. Lond., 1853.

[2] Mackenzie, op. cit., vol. ii. p. 192.

[3] Buist, Charleston Med. Journal, 1858; Conant, Am. Med. Times, p. 209. 1864.

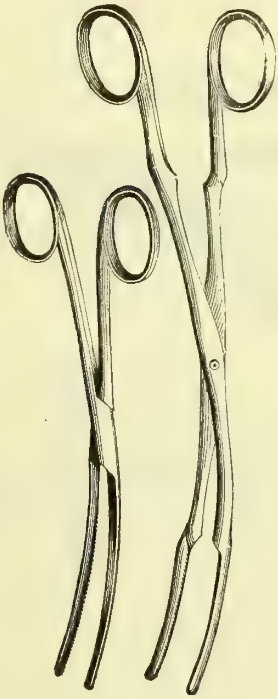
[4] Toussaint Martin, Recueil de Mém. de Méd. de Chir. et de Phar. Militaires, 2e Série, t. xxxvii. p. 260.

[5] Hayem, case cited by Poulet (a set of false teeth were ejected during a fit of coughing, fifteen months after the accident); Evans, Lancet, July 19, 1879, p. 75 (impaction of gold plate and false teeth for upwards of two years, patient having lived in a state of semi-starvation; ejected by emesis); Gastellier, Journ. Gén. de Méd., t. xxiii. p. 147, cited by Poulet (a coin remained lodged for six months, the patient sinking into the last stages of marasmus, and then dropped into the stomach; the patient discharged a large amount of pus; the foreign body was not evacuated until thirty-five years afterwards); Gauthier, case cited by Poulet (a bone discharged by vomiting after fourteen years' impaction in the œsophagus, patient recovering entirely from protracted emaciation and simulated phthisis within six weeks after expulsion).

[6] Habel, Arch. f. klin. Chirurgie, 1862; cited by Poulet.

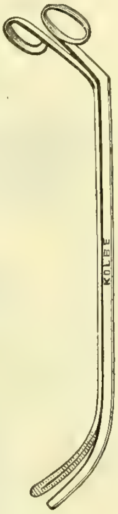
[7] Op. cit., p. 450.

Fig. 1165.



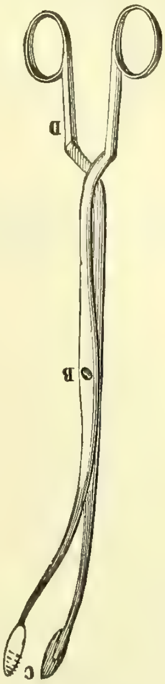
Bond's forceps.

Fig. 1166.



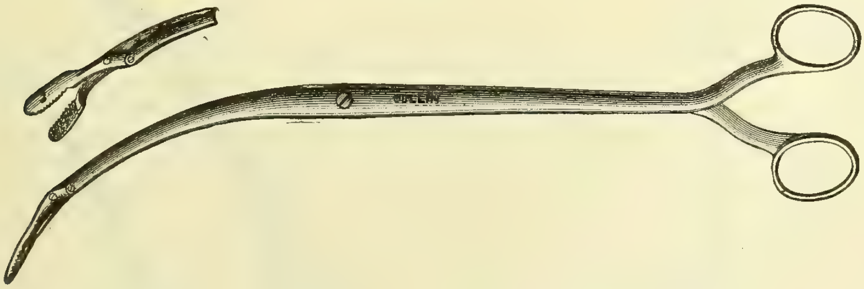
Burge's forceps.

Fig. 1167.



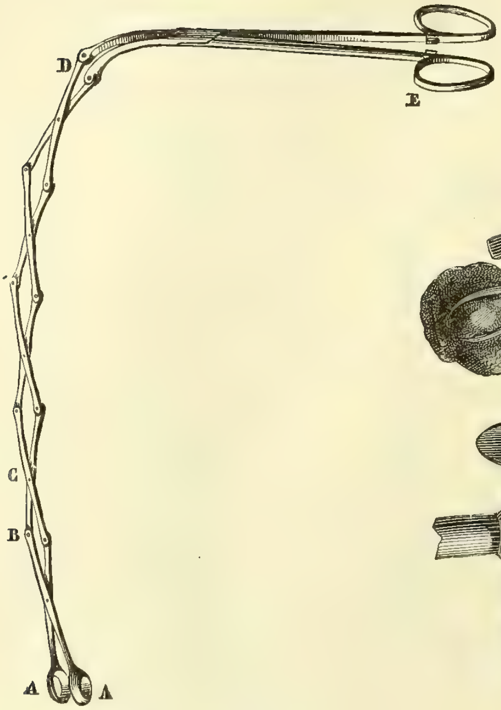
Cloquet's toothed forceps.

Fig. 1168.



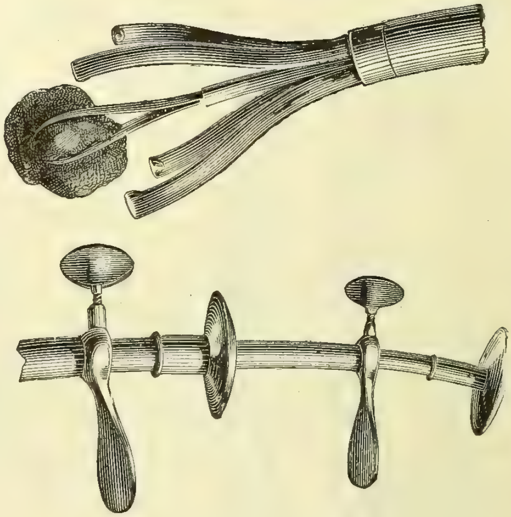
Cusco's forceps.

Fig. 1169.



Mathieu's jointed forceps.

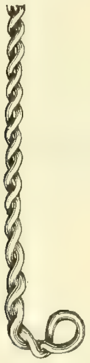
Fig. 1170.



Gama's forceps.

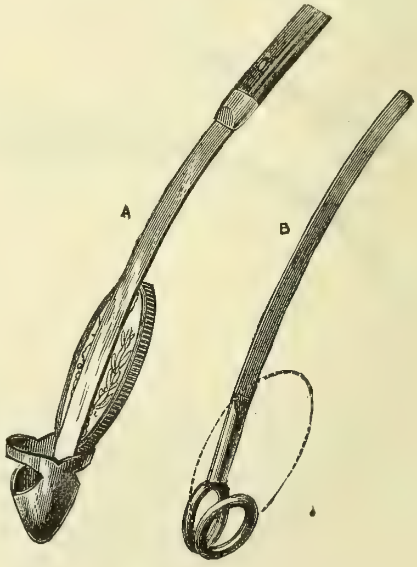
until the sponge becomes swollen by imbibition of moisture, and on its withdrawal in that condition it often sweeps the foreign body before it. Pins, small spicula of bone, and the like, are often readily removed by the horse-hair parasol-snare and probang (Fig. 1174), which is introduced closed, beyond the foreign body, often quite into the stomach,

Fig. 1171.



Petit's hook.

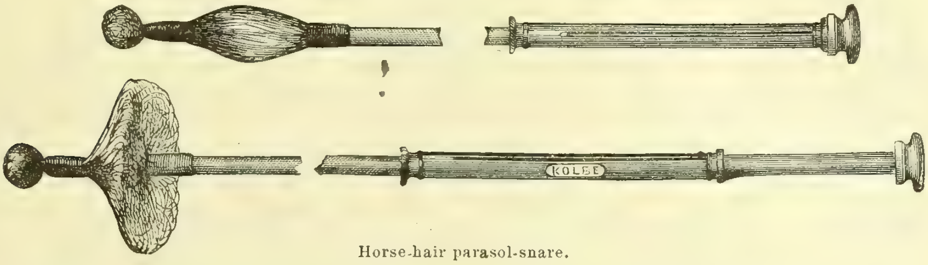
Fig. 1172. Fig. 1173.



Graefe's coin-catcher. Ring coin-catcher.

and is then opened by pulling on the handle as it is withdrawn, so as to sweep the œsophagus and entangle any object which it encounters. Similar instruments with bags of silk and gauze, or with rubber obturators to be inflated with air or water, and the like, have sometimes been employed These instruments should be used with due gentleness. Should the cricoid cartilage present any obstruction to their withdrawal, they should be pressed firmly against the posterior wall of the pharynx. Accidents sometimes follow the use of rigid hooks and coin-catchers. The latter are sometimes tightly caught,[1] so that they become additional foreign bodies, requiring special devices for their removal, and occasionally œsophagotomy.[2] Occasionally their use precipitates a fatal result.[3] The mucous membrane is sometimes bruised in the bite of forceps. Erosions take place with the use of either the sponge or the horse-hair probang. Substances too large for safe withdrawal in bulk, can sometimes be fractured in the forceps so as to be withdrawn or ejected piecemeal, or be passed on into the stomach by peristalsis. It is possible that an operation like that of lithotrity might be practised to crush or drill through hard impacted bodies, especially when beyond the ordinary resources of surgical art, in the thoracic portion of the œsophagus. If at all practicable, all these manipulations should be performed without anæsthesia, as the voluntary co-operation of the patient is highly desirable, and sometimes all important. With children and nervous adults, anæsthesia is permissible when resistance is offered to the manipulations. Under all circumstances, and especially with children, it is a matter of useful precaution to bind the patient's arms firmly to the trunk, so that he cannot use them to incommode or baffle the surgeon.

Fig. 1174.



Horse-hair parasol-snare.

When foreign bodies cannot be readily extracted, it is a common practice to attempt to force them into the stomach by mechanical means. This procedure is perfectly legitimate with digestible substances, or those of a character to favor their safe transit through the intestinal tract. While such irregular bodies as dental plates with teeth,[4] keys, safety-pins,[5] and forks, etc.,[6] have been safely voided through the rectum, a copper coin has been known to excite fatal enteritis.[7] Some forethought is necessary before making this irrecoverable disposition of the foreign body. In an emergency, the stiff stem of some plant—that of the leek being especially adapted to the purpose—the handle of a whip, or some similar object, may be used to push the foreign body into the stomach. The sponge-probang securely attached to a flexible rod of whalebone or of metal, is the special appliance most apt to be accessible, and is at the same time one of the best. Any instrument which is to be used, should be well oiled, introduced carefully, propelled without force, and passed on into the stomach, so as to afford as much evidence as possible that the foreign body has been pushed out of the œsophagus. It is not always possible to determine that the foreign body has reached the stomach. In case of doubt, the subsidence of characteristic symptoms and their non-recurrence may be regarded as indicating that such has been the case. Force should never be used, lest injury be done to the œsophagus. When resistance is encountered, it is far better to wait awhile, and then to try again. Soft substances undergo further softening during a few hours' exposure to the secretions of the œsophagus, and then they yield more readily to pressure from above. Attempts should not be made to push irregular bodies, such as fragments of bone and dental plates, down into the stomach. It is only by accident that irreparable injury is not thus inflicted. I have elsewhere cited[1] an instance of œsophago-tracheal fistula produced in this manner. In a more recent example of this silly and reprehensible practice, it was possible subsequently to remove the foreign body with forceps;[2] but, as a rule, the offending substance is pushed beyond the reach of instruments, and the walls of the œsophagus are lacerated in addition. The pleura has been penetrated in this way, with fatal consequences.[3] The aorta has been penetrated in forcibly propelling a plate with a probang, death ensuing speedily by hemorrhage.[4] The fact that very irregular bodies, such as large plates for false teeth, sometimes pass safely through the alimentary tract, does not justify the practice of pushing such substances through the œsophagus into the stomach, unless they are wholly in the thoracic portion of the gullet; when in this situation, the procedure in question is the sole means of freeing the tube, the injury to which, by their retention, is more liable to be followed by fatal consequences than the injury done by forcing them onwards. It is the choice of the lesser of two great evils, and gives the patient the best chance of survival. Gastrotomy may become necessary in case the foreign body has reached the stomach.[5] In discussing this subject, Billroth[6] calls attention to the fact that it may be necessary, as in a case narrated, to pass the hand directly backward through the abdominal wound in order to detect a foreign body in the posterior portion of the stomach, for the organ cannot be drawn completely out of the wound.

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[1] Adelmann, cited by Langenbeck (Berlin klin. Woch. 17 und 24 Dec. 1876); London Med. Record, Feb. 15, 1878; Holmes, Med. Times and Gaz., Jan. 13, 1883.

[2] Holmes, loc. cit.

[3] Créquy, Gaz. Hebd., 1861; cited by Poulet (Demarquay's case).

[4] Several unpublished examples are known to me.

[5] Packard, Philadelphia Medical Times, April 15, 1872, p. 26.

[6] Adelmann (Congress of German Surgeons, Berlin, 1872), Medical Record, June 1, 1872.

[7] Lee, St. George's Hospital Reports, 1869, p. 219.

The special character of the foreign body and its location sometimes spur the ingenuity of the surgeon into devising, for the occasion, special methods of treatment, both manual and instrumental. Thus, a large potato impacted in the cervical portion of the œsophagus has been broken up by external pressure with the fingers,[7] so that its deglutition could be finished. Similar manipulations have sufficed to propel masses of meat downward in one instance, and within grasp of forceps in another;[8] and have partially succeeded even at the hands of the patient.[9] The extraction of fish-hooks has been accomplished by sliding a slit bullet[10] along the line, to disengage the point of the hook by gravity, and then cover it with the slot; or with a reed attached, so as to protect the mucous membrane from laceration in its withdrawal;[1] and the same object has been accomplished by passing a large catheter along the line[2] to free the hook by pressure, and then drawing it within the instrument. An impacted bone, resisting dislodgment with forceps, has been removed in the following ingenious manner:[3] A few lead pellets, firmly secured to suture-wires, were dropped down the œsophagus, the meshes of wire engaging the bone which was released from its position by pulling on the wires two or three at a time, and varying the threads at intervals. In case a foreign body is so firmly fixed in the cervical portion of the œsophagus that it cannot be dislodged by instruments passed through the mouth, the operation of external œsophagotomy is required. It is especially indicated in cases associated with stricture of the œsophagus. According to the expressed opinion of nearly all writers, it is of little avail, and often of none, in cases of foreign body in the thoracic portion of the œsophagus. Yet it has been successful in apparently the only two cases[4] of the kind in which it has been attempted, though it must be mentioned that the object was comparatively high up, in both instances. It is possible that the linked forceps (Fig. 1169) might be used after œsophagotomy with advantage, or that a specially constructed appliance for seizing a body and boring through it could be contrived, so as to render extraction or propulsion practicable, even for foreign bodies in the thoracic portion of the gullet. Œsophagotomy should be performed as soon as it is found that intra-œsophageal methods are fruitless. Delay merely compromises the success of a legitimate operation, and adds risk of serious sequelæ, such as ulceration and septicæmia, in consequence. Œsophagotomy for foreign body is usually successful,[5] even in the infant,[6] if performed at an early date.

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[1] Op. cit., p. 313.

[2] Lyons, Med. Times and Gaz., March 5, 1881, p. 279.

[3] Stromeyer, Handbuch der Chirurgie, S. 334. Freiburg, 1865; Green, Brit. Med. Jour., Dec. 17, 1870, p. 65.

[4] Clark, Brit. Med. Jour., March 22, 1884.

[5] See Vol. V., page 989, *supra*.

[6] Medical Times and Gazette, April 18, 1885, p. 504.

[7] Dupuytren, case cited by Luton (Dict. de Médecine, Art. Œsophage), by Poulet, and by others.

[8] Langenbeck, Berlin. klin. Woch., 17 und 24 Dec. 1876.

[9] Atherton, Boston Med. and Surg. Journal, 1870; cited by Mackenzie.

[10] Baud, Annales de la Soc. d'Anvers, and Rev. Méd.-Chir. de Paris, t. iii. p. 44, 1848.

After expulsion or extraction of the foreign body, the abnormal phenomena gradually subside, as a rule, the patient recovering within a few days, unless serious injury has been sustained by the œsophagus. Should grave injury have been sustained, the following sequelæ may follow: œsophagitis, circumscribed or diffuse, often proceeding to suppuration; or peri-œsophagitis, whether suppurative or not, terminating, perhaps, with perforation of the œsophagus into the mediastinum, the air-tube, the pleura, the aorta or other bloodvessel. These sequelæ must be treated on general principles. Rest of body, and administration of nutriment by enemata, of tonics, and of anodynes by enema or by hypodermic injection, would constitute the general course of management, to be associated with the prompt evacuation of any abscess pointing externally, or otherwise accessible. The operative details of œsophagotomy will be considered hereafter.

MALFORMATIONS OF THE ŒSOPHAGUS.

Collations show that between sixty and seventy cases of œsophageal malformation are now on record,[7] four having been reported in the United States.[8]

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[1] Leroy, Medical Examiner; Rev. Méd.-Chir. de Paris, t. ii. p. 110, 1847 (cited by Luton).

[2] Laurent, Lancet, vol. ii. p. 745. 1882.

[3] Torrance, Brit. Med. Jour., June 19, 1875, p. 810.

[4] Bégin, loc. cit., t. xxxiii. p. 244, 1832 (cited by Terrier); Arnold, Il Morgagni, Anno IV., p. 352, 1864 (also cited by Terrier).

[5] Ashhurst, Principles and Practice of Surgery, 4th ed. Phila. 1885 (fifty-two times out of sixty-five).

[6] Billroth, Arch. f. klin. Chir., Bd. xv. S. 678; Id., Clinical Surgery, p. 131. London, 1881 (a child one year of age, with stricture).

[7] Mondière, Arch. Gén. de Méd., t. ii. p. 505. 1833; Hirschsprung, Den Medfodte Tillukning af Spiseroret, cited by Mackenzie (op. cit., vol. ii., London, 1884); Michel, Dictionnaire Encyclopédique des Sciences Médicales, Art. Œsophage. Paris, 1880.

[8] Catalogue of the Boston Society for Medical Improvement, p. 128 (two cases, specimens 456, 457); Catalogue of the U. S. Army Medical Museum. Washington, 1867; Lamb, Philadelphia Medical Times, 1873, p. 705.

In addition, there are a few records of transposition of the œsophagus, and one or more of annular bifurcation with rejunction.[1] The great majority of cases of malformation of the œsophagus occur in individuals with malformations elsewhere. Of 63 patients referred to by Mackenzie, concerning only three was it stated that there was no other deformity, while in 19 others the condition of other organs was not mentioned, or it was stated that they had not been examined. In fully two-thirds of these malformations, 43 out of 63, the deformity consisted of a central deficiency of the œsophagus, the two extremities communicating with the air-passages—by far most frequently (40 instances out of the 43), with the trachea, and in the remaining instances with the bronchi. This deformity approaches teratologically the annular bifurcation of the intact œsophagus, and seems to indicate that the gullet may be developed from centres at its extremities. In nine instances the œsophagus terminated in a blind pouch ; in five there was no œsophagus at all; in two there was inter-communication with the trachea, the œsophagus being otherwise normal ; in one the diaphragm shut off the œsophagus ; in one there was a complete membranous partition in the cervical portion ; in one there was a permeable valvular membranous obstruction in the cervical portion ; in one there was a longitudinal division of the œsophagus ; and in one there was a probably congenital pouch. Embryologists have not yet accounted satisfactorily for malformations of the gullet.

Diagnosis.—The question of the existence of a malformation may be entertained when the infant rejects by mouth, or by mouth and nose, nearly all the milk taken, unaltered in appearance. Symptoms of suffocation often attend attempts to nurse, in instances where the œsophagus is in communication with the air-passage. Careful exploration with a sound, in such instances, ought to reveal either an obstruction at some point of the tube, or a communication with the air-passage.

Prognosis.—Surgery as yet seems to afford no hope for relief in these cases. For cases of supposed simple imperforation, without communication with the air-passages, the suggestion has been made[2] to cut down upon the point of a guide introduced into the pharynx, and then to attempt to trace the obliterated œsophagus down the front of the spine until its lower dilated portion should be found. Then a gum catheter could be passed through the lower portion. If the two portions were sufficiently near each other to be connected by silver sutures over the catheter, and if the latter could be retained until union had taken place, it is thought that permanent success might be obtained. I am unaware that these views have been adopted by other surgeons. It is possible that good results might follow attempts at relief by gastrostomy. In most of the cases alluded to, death has taken place at periods varying from two hours to twelve days—a matter of normal vigor, apparently independent of the nature of the malformation. In one exceptional case of tracheo-œsophageal fistula, with otherwise normal œsophagus, the subject lived seven weeks,[3] owing to the favorable form of the fistula, which hindered to some extent the escape of matters into the air-passage.

MORBID GROWTHS OF THE ŒSOPHAGUS.

BENIGN GROWTHS.—Benign morbid growths of the œsophagus are rare. As most of the recorded cases,[4] some twenty-five in number, were not discovered until after death, and some of them altogether independently of any œsophageal symptoms, it is not improbable that a number of cases of œsophageal tumor escape recognition altogether. In the cases recorded, males have been the subjects far oftener than females. These growths are much more frequently pedunculated than sessile, and hence the earlier cases have been chiefly mentioned as polypi. In about half the cases, attempts have been made at histological discrimination, in some instances with the aid of the microscope. Fibromata predominate. Then come myomata, of which there are records of four cases;[1] cystomata, three cases;[2] adenoma, one case;[3] inflammatory neoplasm[4]—probably a sub-epithelial granuloma—one case. Papillary excrescences, from the size of a pin's head to that of a lentil, sometimes single and sometimes multiple,[5] are said to be quite frequent in elderly persons. Benign growths are almost always single, examples of multiple growth, other than the papilloma just alluded to, being quite rare.[6] The size of cysts varies from that of a very minute pea to that of a hazel-nut, and exceptionally to that of an apple.[7] Fibromas may reach the bulk of a sausage,[8] but few of them are larger than hazel-nuts. They are usually smooth in contour, sometimes lobulated.[9] Of a number of cases in which the location was determined, in seven the growths occupied the upper portion,[10] in three[11] the cardiac portion, in one a point just below the level of the bifurcation of the trachea,[12] in one a point $6\frac{3}{4}$ inches below the glottis,[13] in one the lower third,[14] and in one the lower part of the middle third of the gullet.[15] In two cases it is stated that the anterior wall was occupied, in two the posterior wall, in one the left side, and in one the right; so that there seems to be little special proclivity in regard to position. Some seem to have taken origin in the epithelium, some in the mucous follicles, and some in the muscular coat.

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[1] Blasius, Observationes medicæ rariores. Lugd. Bat., 1674 ; cited by Mondière (Arch. Gén. de Méd., 2e série, t. ii. p. 507, 1833) ; Sebastien and St. Hilaire, case cited by Michel (loc. cit.).

[2] Holmes, Surgical Treatment of Children's Diseases.

[3] Lamb, loc. cit.

[4] Collated by Voigtel, Handbuch der pathologisch. Anatomie, Bd. ii. S. 427. 1804 (cited by Zenker and Ziemssen) ; Mondière, Arch. Gén. de Méd., Sept. 1833, pp. 53–57 ; Middeldorpf, De

Nothing positive is known of the *etiology* of these growths. Excessive use of snuff is mentioned as the cause in the title given to one of the earliest cases on record,[16] and addiction to the pipe and the bottle in another.[17]

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polypis œsophagi atque de tumore ejus generis primo extirpato. Bratislav., 1857; Zenker and Ziemssen, Cyclopædia of the Practice of Medicine, vol. viii. pp. 167–170. New York, 1878; Mackenzie, op. cit., vol. ii. p. 99.

[1] Eberth, Arch. f. path. Anat. u. s. w., Bd. xliii. S. 137. 1868; Coats, Glasgow Medical Journal, Feb. 1872; Fagge, Med. Times and Gaz., Nov. 28, 1874; Trans. Path. Soc. Lond., vol. xxxi. p. 94; Tonoli, Gazetta Medica Ital. Lombard., Serie viii., t. ii. No. 49, p. 439. 1880 (cited by Mackenzie).

[2] Wyss, Arch. f. path. Anat. u. s. w., Bd. li. S. 144 (a vibratile cyst); Ziemssen, op. cit., vol. viii. p. 161; Sappey, Traité d'Anatomie Descriptive, 3me éd., t. iv. p. 155. Paris, 1879 (cited by Mackenzie).

[3] Weigert, Arch. f. path. Anatomie u. s. w., Bd. lxvii. S. 516.

[4] Mackenzie, op. cit., vol. ii. p. 105.

[5] Zenker and Ziemssen, op. cit., vol. viii. p. 168.

[6] Schneider, Chirurgische Geschichte, Bd. x. Chemnitz, 1784; cited by Mondière and others (three polypous excrescences, two pedunculated, one sessile); Bell, Surgical Observations, vol. i. p. 77. London 1816; Sappey, op. cit., t. iv. p. 155, cited by Mackenzie (about 20 small cysts).

[7] Wyss, loc. cit.

[8] Monro, Edinburgh Physical and Literary Essays, vol. ii. p. 525, and vol. iii. p. 212; Monro, Jr., Morbid Anatomy of the Gullet, Stomach, and Intestines, p. 186. Edinburgh, 1811 (the tumor, a portion of which had been removed by ligature two years previously, was found, after death, to extend from a point of attachment on the anterior wall, three inches below the glottis, quite to the cardiac extremity of the stomach); Bell, op. cit. (a large irregular tumor); Rokitansky, Med. Jahrb. d. k. k. österr. Staates, n. F., Bd. xxi. S. 225. 1840 (seven and a half inches in length, and two and a half inches broad at its broadest part. In Middeldorpf's case, the part removed measured 3 x $1\frac{1}{2}$ inches; in Coats's case, $4\frac{3}{4}$ x 2 x $1\frac{1}{4}$ in.; in Fagge's 2 x $1\frac{1}{4}$ x 1 in.).

[9] Dallas's case, reported by Monro and Bell.

[10] Cases of Dallas, Bell, Dubois, Middeldorpf, Hofer, Arrowsmith, and Mackenzie (two).

[11] Cases of Vater, Graef, Wyss.

[12] Fagge's case.

[13] Coats's case.

[14] Weigert's case.

[15] Tonoli's case.

[16] Schmieder, De polypo œsophagi vermiformi rarissimo a quotidiano pulveris sternutatorii Hispaniæ abusu progenito. Halæ, 1717.

[17] Graef, Diss. med. inaug. illustrans historiam de callosâ excrescentiâ œsophagum obstruente, mortis causâ Altorfii, 1764.

Some instances have been deemed congenital. It is probable that the exciting cause, as in many morbid growths elsewhere, is to be attributed to topical inflammation, possibly the result of pressure.

Symptoms.—Dysphagia, emesis, cough, dyspnœa, imperfect articulation, and pain in the throat, chest, or back, are the chief symptoms that have been manifested, not all of them, however, in any individual instance. Theoretically, dysphagia would be deemed a prominent symptom; and in several instances progressive dysphagia has been experienced. Yet it has often been wanting, even when the tumors have been of the largest size.[1] When pedunculated and situated high up, they are sometimes regurgitated into the pharynx,[2] and, if at all large, may so threaten suffocation as to prompt the patient to his sole means of immediate relief—the swallowing of the tumor—so as to restore it to its safer position in the œsophagus. Dyspnœa, indistinct articulation, and great pain, have been experienced in individual cases. In several instances[3] there have been no symptoms whatever to suggest the existence of a tumor.

Diagnosis.—In most of the cases on record the affection has been diagnosticated after death.[4] In a few cases it has been recognized during life,[5] once by spontaneous ejection[6] of the tumor, and in other instances by its regurgitation into the pharynx,[7] or even into the mouth.[8] Some growths have been detected by exploration with the sound;[9] sometimes the diagnosis has been made by finding the trachea free on catheterization for dyspnœa,[10] and once by œsophagoscopy.[11] Spontaneous exhibition and instrumental exploration, then, constitute the means of diagnosis. Auscultation of the œsophagus, too, might furnish additional indications of obstruction. Minute growths, even though they might give rise to dysphagia, would probably escape recognition. There are a few instances on record of tumors hanging into the œsophagus,[12] their points of origin having been the epiglottis, the larynx, the pharynx, or the posterior nares. These are to be discriminated from essential tumors of the œsophagus.

Prognosis.—The prognosis is not unfavorable, provided that growths which give rise to dysphagia and to dyspnœa are amenable to surgical measures for relief. In the absence of such relief, the prognosis in such cases is unfavorable. If dysphagia be progressive, and if the disease remain unrecognized or unrelieved, death ensues by inanition.[13]

Treatment.—Several instances have been alluded to in which the growth has been ligated. Operations of this kind are not easy of execution. In one case, the surgeon[14] insured the appearance of the tumor by administering an emetic, and then, having seized it with Museux's forceps, drew it to the left side to somewhat relieve the dyspnœa, and severed the polypus about three-fourths of an inch in front of the ligature, the entire procedure being performed in the midst of repeated vomitings and in the presence of great dyspnœa. The patient then swallowed the pedicle with the ligature, the ends of which were attached to the left ear for safety. The vomiting, the oppression, and the dyspnœa immediately ceased, not to return. The loop of the ligature appeared in the mouth on the eighteenth day. The patient was

[1] Rokitansky's case.

[2] Cases of Dallas, Middeldorpf, Hofer, and Dubois.

[3] Those reported by Schmieder, Eberth, and Fagge.

[4] Cases of Schmieder, Schneider, Graef, Pringle, Baillie, Arrowsmith, Coats, and Fagge.

[5] Those of Vater, Dallas, Hofer, Dubois, Tonoli, and Middeldorpf.

[6] Vater.

[7] Hofer, Dubois, and Middeldorpf.

[8] Dallas.

[9] Middeldorpf, Tonoli.

[10] Richards, Proceedings of the American Laryngological Association, June 12, 1879.

[11] Mackenzie, op. cit., vol. ii. p. 100.

[12] Gibb, The Throat and the Windpipe, p. 361. London, 1861; Warren, Surgical Observations, p. 116. Boston, 1866.

[13] Cases of Schneider and Graef.

[14] Middeldorpf.

doing well five years after the operation. In another case[1] it was necessary to perform precautionary tracheotomy before ligating the tumor. In this instance the ligated portions of the tumor were passed by the rectum, but the patient died of inanition two years afterwards, from dysphagia caused by the portions left behind. The propriety of securing the ligature externally in order to control the tumor in case of accident, is exemplified by an instance in which a patient was found dead in bed some days after this operation, with the tumor in his pharynx completely occluding the larynx.[2] Another successful case of ligature completes,[3] it is believed, the records of this procedure. At the present day it is likely that the electric-cautery loop might be employed instead of the ligature; but the fact that these tumors are sometimes very vascular, and that secondary hemorrhage might be serious, is not to be ignored in selecting the more rapid method of severance.

That removal with the horse-hair parasol-probang can be accomplished in cases of growths with soft attachments, has been shown by two accidental instances in which that manipulation had been undertaken for supposed foreign bodies.[4] One case of removal of a growth the size of a white currant, discovered œsophagoscopically, is on record;[5] but the nature of the operation is not indicated. Œsophagotomy has been suggested for access to tumors high up, and gastrotomy for those low down; but no records of these procedures having been practised in cases of the kind now under consideration have come to my knowledge.

Malign Growths.—(1) *Sarcoma.*—But two records of sarcoma of the œsophagus seem to be accessible. In one, digital exploration produced such dyspnœa that tracheotomy had to be performed immediately; the tumor, a round-celled sarcoma, being subsequently removed by subhyoidean pharyngotomy from the right side of the œsophagus just below its pharyngeal orifice.[6] The other, an alveolar sarcoma at the entrance of the œsophagus, occurred in a woman who died of inanition.[7] Several tumors, partially connected, and varying in diameter from half an inch to two inches, occupied the lower part of the pharynx and the upper part of the œsophagus, almost occluding the latter.

(2) *Carcinoma.*—Carcinoma of the œsophagus is far more frequent than the other varieties of morbid growth, if not more frequent than any other form of œsophageal disease. Judging from my own practice and that of my associates in Philadelphia, the belief is entertained that the published cases of carcinoma of the œsophagus represent but a small proportion of the cases actually observed. Still, it is far rarer than carcinoma of the stomach[8] and of some other organs.

Carcinoma of the œsophagus is most frequently of the squamous-celled variety of epithelioma, fifty-four of the fifty-nine cases studied by Mr. Butlin[9] having been of this histological character, as compared with three small spheroidal-celled (scirrhous), one large spheroidal-celled (medullary), and one colloid carcinoma.[1] There does not appear to be any marked proclivity in any special portion of the œsophagus to become affected. While some observers note the disease as most frequent in the upper third,[2] others note it most frequently in the lower third,[3] and still others in the middle portion.[4] The disease has been known to involve the entire length of the organ.[5] Whatever portion be found involved after death, it is not always possible to determine whether the main tract of extension has been upward or downward.

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[1] Dallas's case, cited by Monro (London Medical Journal, 1771, and Edinburgh Physical and Literary Essays, vol. iii. p. 212); Monro, Jr., op. cit., p. 186.

[2] Dubois, Propositions sur diverses parties de l'art de guérir, p. 8. Thèse No. 104, Paris, 1818; cited by Mondière.

[3] Hofer, Acta Helvetica, tom. i.; cited by Mondière.

[4] Mackenzie, op. cit., vol. ii. p. 104.

[5] Ibid.

[6] Rosenbach, Berliner klinische Wochenschrift, 20 und 27 Sept. 1875.

[7] Chapman, Am. Journ. Med. Sci., Oct. 1877, p. 433.

[8] Tanchon, in a total of 9118 cases of cancer, found 2303 of the stomach and but 13 of the œsophagus; cited by Lebert (Traité Pratique des Maladies Cancereuses, Sect. III., p. 442. Paris, 1851).

[9] Sarcoma and Carcinoma, p. 161. London, 1882.

Carcinoma of the œsophagus is usually primary, and it does not always cause secondary infection. Secondary manifestations may occupy the lymphatic bronchial glands, the liver—the left lobe most frequently—and the gastric glands. Secondary infection is much the least frequent in the small spheroidal-celled variety of carcinoma (scirrhus). The disease rarely remains limited to the organ. Infiltration of the stomach by contiguity is not uncommon when the cardiac extremity of the œsophagus is the seat of the disease. Infiltration takes place likewise into the cervical and mediastinal connective tissue; the trachea, bronchi, and lungs; the aorta and other blood-vessels. Ulceration ensuing, perforation may occur into the trachea, the bronchi, the pleura, or the lung, the aorta, the pulmonary, subclavian, or carotid artery, or the internal jugular vein. Pressure on the recurrent laryngeal nerve gives rise to paralysis of the laryngeal muscles, necessitating tracheotomy when the dilating muscles are involved on both sides.

Sometimes the disease is an extension from carcinoma of the tongue, epiglottis, larynx, pharynx, stomach, or mediastinum. The manner in which the disease begins and spreads is a matter chiefly of theoretical inference, literally beyond our ken. However this may be, it usually ultimately involves the organ in its entire circumference.

Ulceration begins early in its pathological history, and very few specimens are observed without it.[6] It usually involves the entire circumference in an irregular outline, isolated patches of ulceration being often found in addition. When the ulceration is not annular, it does not seem that the anterior wall is more apt to suffer than the posterior. The ulceration sometimes extends into the adjoining infiltrated tissues to which the œsophagus may have become agglutinated, and perforation thus takes place into the structures mentioned. As the disease progresses, it produces stricture, and then obliteration of the calibre of the œsophagus. After death, the diseased tissue appears in small, roundish, projecting masses covered by epithelium, or in the form of vegetations or deeply ulcerating masses. The coats of the œsophagus in the vicinity are often thickened, especially the muscular coat; and then dilatation sometimes exists above the constriction.

Etiology.—Sex, heredity, and age appear to be predisposing influences. Males are more liable than females. Thus Zenker reports 11 cases out of 15 in males, Mackenzie 71 out of 100, Butlin 47 out of 59, Lebert 8 out of 11, Petri 41 out of 44, and Ziemssen 17 out of 18. This preponderance may be due to the great tendency, in the other sex, for carcinoma to attack the mamma and the uterus.[7] One observer[8] found a family history of malignant disease in all the cases, ten, of carcinoma which he had met with; but this is an exceptional experience. Mackenzie[9] found a similar history in but eleven cases out of sixty. Though carcinoma of the œsophagus is infrequent in the actual subjects of tuberculosis, it is met with sufficiently often in the children of tuberculous subjects to suggest the idea of some hereditary predisposition induced by that diathesis. From a comparison of several series of records, and of many individual reports, comprising a total of more than two hundred cases, it appears that the disease is rare before the thirteenth year of life. Few cases occur before the age of thirty-five, most of them between the ages of forty and seventy. Epithelioma, or squamous-celled carcinoma, seems to be the only variety likely to appear before the forty-fifth year. The greatest proclivity seems to be manifested between the ages of fifty and sixty. The average age at which women are attacked is about ten years earlier than the average age in men, say forty-four and fifty-four respectively. It occurs in advanced old age, cases having occurred in subjects as old as eighty-four[1] and eighty-six.[2] It is frequently admitted that abuse of alcoholic beverages may predispose to the disease, but this point is a matter of uncertainty. Local inflammations, and injuries by pressure or by compression, are regarded as exciting causes.

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[1] Bristowe, Trans. Path. Soc. Lond., vol. xix. p. 228. 1868.

[2] Hunter, Habershon, Mackenzie, Butlin.

[3] Petri, Zenker, Ziemssen.

[4] Klebs, Rindfleisch.

[5] Zenker.

[6] Five out of fifty-four in Butlin's list.

[7] Koenig. Pitha und Billroth's Handbuch, Bd. iii. S. 32.

[8] Richardson, Trans. Saint Andrew's Med. Grad. Assoc., vol. vi. p. 184.

[9] Op. cit., vol. ii. p. 73.

Symptoms.—These may be summed up as progressive dysphagia—first with solids and then with fluids likewise, sometimes becoming more and more painful and sometimes painless—regurgitation, vomiting, loss of appetite, dyspnœa, dysphonia, cough, pyrexia, and marasmus; and subsequently such symptoms as are produced by extension of the disease in adjacent organs and structures, and by perforation into them. Lancinating pains occur in some instances. After ulceration has taken place, enlarging somewhat the passage for food, the dysphagia undergoes proportionate temporary amelioration.

Diagnosis.—The presence of several or all of the symptoms enumerated, their steady and rapid exacerbation, the age of the patient, and the recognition of carcinomatous tissue in the purulent and sanguinolent matters vomited, furnish the chief grounds for diagnosis. The existence of obstruction by tumor or by stricture, is determined in the usual manner by exploration with the sound, and by auscultation of the bolus. Characteristic shuttle-like pains are not common, and cachexia fails to be produced in many cases of rapid progress. Their absence therefore does not invalidate the diagnosis. In the earlier stages, carcinoma is liable to be mistaken for chronic œsophagitis, the presence of a cicatricial stricture or of a diverticulum, and involution from compression on the exterior.

Prognosis.—The prognosis is unfavorable, the disease being inevitably fatal at a period varying from three months to two years, or a little more. Death may even take place as early as seven or five weeks[3] after the manifestation of dysphagia.[4] More than one-half the cases seem to terminate fatally within six months, and five-sixths within twelve months. Life is longest preserved in cases of small spheroidal-celled carcinoma (scirrhus), instances being on record of its preservation for more than two years, and exceptionally beyond three. While some cases are fatal by inanition, others terminate before this condition is reached, whether by pneumonia, gangrene, or other disease of the lung, or by suffocation, pericarditis, hemorrhage, or disease of the spinal cord, according to the direction and result of the consecutive infiltration. The position of the disease and the liability to occlusion of the œsophagus and to the consecutive diseases and conditions just mentioned, influence the prognosis as to the probable length of life and the probable mode of its termination.

Treatment.—This is palliative, and to be conducted on general principles. Arsenic may be employed medicinally with some hope of retarding the progress of the disease in its earlier stages. Dilatation of the constricted canal is allowable only at the commencement. When alimentation becomes difficult, the stomach-tube may be cautiously used at first. At a later date a catheter may be retained in the œsophagus a few days at a time, for the purpose of injecting food into the stomach. Otherwise, rectal alimentation is indicated. This should not be delayed until it is absolutely necessary. Occasional rest to the part, afforded by resort to this mode of alimentation, sometimes temporarily restores the ability to swallow. In the later stages, especially after ulceration has begun, there is great danger of penetrating the walls of the œsophagus with instruments, whether inserted for probing, for dilating, or for conveying nutriment. Œsophagostomy offers no hope of relief. Gastrostomy may permit the prolongation of life in cases favorable for the operation. Resection of the œsophagus, partial œsophagectomy, seems in the light of present histological pathology to present considerable chance of benefit, if not of cure, provided that the whole of the diseased structure can be included in the excised portion of the œsophagus. The procedure is applicable only to disease of moderate extent, involving the upper portion of the gullet.

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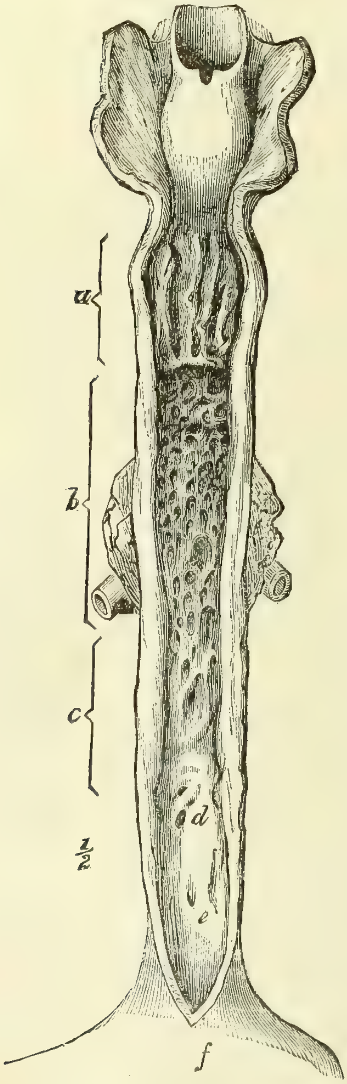
[1] Butlin's list.

[2] Béhier's list.

[3] Mackenzie, op. cit., vol. ii. p. 92.

[4] Habershon.

Fig. 1175.



Traumatic stricture of the œsophagus. (After Mackenzie.)

At any stage of the disease, threatened suffocation, whether from compression of the air-tube or from paralysis of the laryngeal muscles, may demand tracheotomy.

STRICTURE OF THE ŒSOPHAGUS.

Stricture of the œsophagus is occasionally congenital, and sometimes inflammatory; but it is much more frequently cicatricial, occurring usually as the result of injury to the part or of disease within the organ, in its walls, or directly outside. The intrinsic injuries are most frequently lacerative, and the diseases ulcerative. Cicatricial stricture is most frequent at the uppermost portion of the œsophagus, but it also occurs lower down, even just above the cardiac orifice of the stomach.[1] Traumatic stricture has been known to extend from within half an inch of the cricoid cartilage to within an inch of the cardia[2] (Fig. 1175), but in most instances it does not extend over more than three inches. Usually there is but one stricture, but in some instances there are two, three, or as many as four.[3] The occlusion of the canal is occasionally complete, and may vary between this extreme and very slight obstruction.

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[1] Maury, American Journ. Med. Sciences, April, 1870, p. 369; Rawdon, Liverpool Med. and Surg. Rep., vol. iii. p. 117; Reid, New York Medical Journal, Oct. 1877, p. 405.

[2] Mackenzie, op. cit., vol. ii. p. 154.

[3] Cohen, op. cit., p. 291.

Cicatricial strictures occur in the form of folds, bands, nodules, and agglutinations of opposing surfaces. Repeated detention of food sometimes dilates the œsophagus just above the stricture, hypertrophy occurring first, and fatty degeneration afterwards. Atrophy is not uncommon below tight strictures, and collapse of the tube usually follows.

Etiology.—The causes of œsophageal stricture are obscure in some instances. They are most frequently traumatic, and due to scalds, to chemical disintegration following the deglutition of weak or strong acid or alkaline liquids, to laceration, or to destructive inflammation and cicatrization following mechanical injury or the impaction of foreign bodies. Intrinsic strictures are also produced by carcinoma, syphilis, tuberculosis, neoplasms, varices, abscesses, connective-tissue or muscular hyperplasia, and even osseous infiltration. Strictures by outside compression are produced by abscesses, morbid growths, enlarged thyroids, enlarged lymphatic glands, and aneurisms of the aorta.

Symptoms.—The characteristic symptoms are persistent and often progressive dysphagia, and regurgitation. In addition, there may be pain, sense of oppression in the chest, and nervous disturbance. In organic stricture, implicating the course of the pneumogastric and inferior laryngeal nerves, there may be dyspnœa, dysphonia, and spasm.

Diagnosis.—The history of the case, the existence of dysphagia and regurgitation, evidence on auscultation of impediment to the descent of the bolus, and obstruction detected in catheterization or exploration with the sound, are the pathognomonic guides to diagnosis. Dyspnœa and dysphonia will suggest stricture of organic origin, the latter more especially should a vocal band exhibit paralysis. Any morbid products or fragments of tissue, brought to light by regurgitation or by catheterization, will serve to indicate the nature of the lesion which produces the stricture.

Prognosis.—The prognosis is unfavorable in incurable organic stricture. It is comparatively favorable in cicatricial stricture of moderate dimensions, especially when due to a curable disease, or when susceptible to dilatation, to division by œsophagotomy, or to circumvention by œsophagostomy or gastrostomy. Cicatricial stricture of traumatic origin may exist for many years before the patient succumbs to inanition. During the process of hypertrophy above the stricture, muscular power forces nutriment through the stricture; but when fatty degeneration begins, this power becomes lost and marasmus ensues. Meantime abscess may occur, and fatal pneumonia or pulmonary gangrene may end the struggle for life.

Treatment.—The medicinal and hygienic treatment of patients with stricture varies with its character. The surgical treatment requires in the first place proper measures for the removal of any foreign body, morbid growth, collection of pus, or other pathological condition remediable by surgical means. For the cure or amelioration of the stricture itself, the treatment, according to the indications, will be by simple dilatation, forced dilatation, or dilatation after section of the stricture—whether by internal œsophagotomy, or by direct access through the wound of external œsophagotomy or that of gastrotomy. The value of persistent, progressive dilatation, especially in cases of traumatic stricture, is not sufficiently appreciated by all surgeons. That much of the difficulty in cases of supposed unyielding strictures is sometimes due to spasm from attendant irritation—as has been expressed by Michel, Annandale, and Campbell, in particular—seems demonstrated in the successful, accidental dilatation[1] effected by the swelling of a piece of dried peach, incautiously swallowed in a case of supposed impassable stricture.

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[1] Smith, Med. and Surg. Reporter, Dec. 6, 1884, p. 641.

This hint might be utilized in suitable cases by allowing the patient to swallow some easily distensible substance (sponge, leather, or other suitable material) secured to a string, so that it might be promptly and safely withdrawn. Proper care would be required to avoid risk of rupturing the œsophageal wall in thus doing. If the stricture be impassable by bougie or inaccessible to œsophagotomy, gastrostomy may be practised. Internal œsophagotomy and digital divulsion are sometimes practised through the wound of gastrotomy. Cauterization and electrolysis are claimed as legitimate procedures, but both are risky—the former as likely to increase the stricture, and the latter as liable to excite fatal syncope by irritating the pneumogastric nerve.

COARCTATION-STRICTURE. (*Extraneous Stenosis.*)—This form of stricture is due to compression outside the œsophagus, forcing one wall close to the other, or into actual contact. It may be due to abscess, enlarged bronchial glands, enlarged thyroid, morbid growth, aneurism, or pericardial effusion. It is to be carefully discriminated from intrinsic stricture. The *diagnosis* is made by exclusion, and by the recognition of cervical or thoracic disease outside of the gullet. The characteristic *symptoms* are dysphagia and pain. The *prognosis*, dependent upon the curability of the primary disease, is on the whole unfavorable. The *treatment* consists in management on general principles, and in careful attempts at dilatation and catheterization for the better supply of nourishment. Cure, or even amelioration of the causal affection, will relieve the constriction. In all cases, however treated or of whatever origin, the importance of keeping up nutrition by rectal alimentation even before this procedure is imperatively necessitated, cannot be too strongly insisted upon.

SPASM AND PARALYSIS OF THE ŒSOPHAGUS.

SPASM OF THE ŒSOPHAGUS, OR ŒSOPHAGISMUS.—This is a neurosis which may exist alone or in association with pharyngismus. It may affect any portion of the tube. The inability to swallow, or rather to complete the process of deglutition, may be transient, or persistent during consecutive series of hours. It is usually manifested irregularly, often suddenly, but may be definitely intermittent, or may even precede every effort at deglutition. In some subjects it occurs only on attempts to swallow certain sorts of food, hot or cold, soft or hard. It is often associated with regurgitation of air or of flatus, and with the globus hystericus. It may be painless or painful. When severe, there may be spasm of the glottis, cardiac disturbance, and syncope.

Etiology.—Œsophagismus occurs in diseases of the œsophagus, but it is usually a reflex neurosis excited by disease of the viscera, genital organs, or nerve-centres, as in hydrophobia. It occurs at all ages, and principally in females, especially hysterical and nervous ones.

Symptoms.—The symptoms are sudden dysphagia, giving way as suddenly as it begins, either at once, or after a prolonged interval which may comprise several hours; and regurgitation, immediate or nearly so when the spasm is located high up, delayed for hours or even for days when the spasm is low down.

Diagnosis.—The suddenness and intermittence of the paroxysms will suggest the diagnosis, and successful catheterization of the œsophagus will confirm it. The tube or bougie is usually arrested at the seat of spasm, but after a few moments' or a minute's rest will glide readily onward on the occurrence of relaxation. The differentiation of nervous spasm from spasm of organic origin, rests in the main on the conservation of good nutrition.

Prognosis.—This is usually favorable, unless there be some serious disease of the nerve-centres, or of some other important organ.

Treatment.—The first passage of the bougie often permanently cures the spasm. Should the relief be but temporary, the procedure can be repeated from time to time. Relaxants, anodynes, and antispasmodics are indicated as medicinal remedies. The periodic warm bath is an excellent measure for children. Painting the pharynx with a weak solution of iodine or of silver-nitrate, every few days; deglutition of these substances in glycerine or in ointment; or their passage along the œsophagus on the probang, cures many obstinate cases. Electrization, sometimes successfully employed, is objectionable for the reasons indicated in speaking of œsophageal stricture.

PARALYSIS OF THE ŒSOPHAGUS.—This may be partial or complete. It may be, and often is, associated with paralysis of the pharynx, palate, tongue, or larynx, with so-called bulbar paralysis, and with general paralysis.

Etiology.—It may be due to disease of the œsophagus; to mechanical restraint by external adhesions; to disease or injury of the fibres of the pneumogastric nerve; to external pressure; to neurasthenia from hemorrhage or from protracted disease; to septic poisoning in syphilis, diphtheria, or plumbism. It may occur suddenly, from shock by fright, or from reaction by chilling the overheated body.

Symptoms.—Partial paralysis may afford no symptoms at all. Dysphagia, deglutition easiest in the erect position, escape of saliva, and, towards the end, escape of fluids and food into the air-passages, constitute the characteristic symptoms.

Diagnosis.—The differential diagnosis rests on the absence of pain and regurgitation, symptoms present in dysphagia from mechanical occlusion of the œsophagus. Auscultation of the bolus may indicate the position and extent of the paralysis.

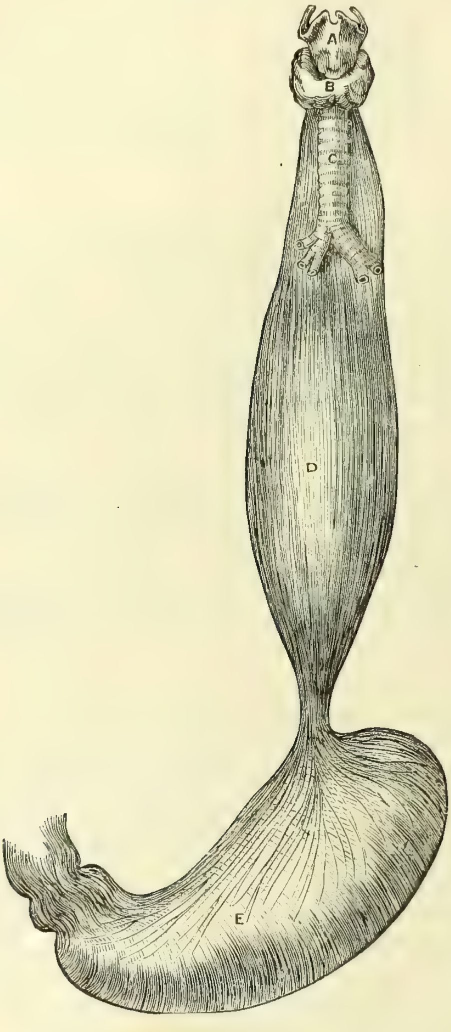
Prognosis.—This is favorable in idiopathic cases, and in those due to curable diseases or injuries, especially when the paralysis is confined to the œsophagus; but recovery is rarely rapid. The prognosis is unfavorable under almost all other conditions.

Treatment.—Surgical treatment is restricted to the passage of the stomach-tube, when required to insure due supplies of nourishment. Preparations of strychnine are indicated for internal administration. Electric treatment is almost as likely to increase the paralysis as to diminish it, and internal electrization is liable to induce fatal syncope.

DILATATION AND SACCULATION OF THE ŒSOPHAGUS.

Dilatation of the œsophagus, or *œsophagocele*, may be general or partial. *General dilatation* involves the whole of the œsophagus from pharynx to stomach, the organ often being stretched as well as dilated (*complete general dilatation*). *Partial dilatation* presents itself in three forms. (1) It may involve the greater portion of the œsophagus from the cardiac orifice to the cervical portion; a form pathologically allied to general dilatation (*incomplete general dilatation*). (2) It may be circumscribed—a limited, circumferential dilatation, forming an ampulla (*annular dilatation*). (3) It may involve but a portion of the periphery in a diverticulum or pouch (*diverticulum*, *pouched dilatation*, *sacculation*). General dilatation is usually fusiform or spindle-shaped, whether complete or incomplete, the greatest enlargement being where the normal diameter is greatest. Complete dilatation varies from slight enlargement to the bulk of a large arm,[1] or four times the normal circumference at the greatest point of enlargement, so that its bulk may nearly equal that of the stomach.[2] In the case illustrated by Fig. 1176, the organ was 46 centimetres in length instead of 29, the normal length, and 30 centimetres in its greatest circumference instead of 7½. In cases of considerable elongation, the œsophagus must form an S-shaped curve; a theory which is supported by the fact that, in one or two instances,[3] stretching of the trunk has been practised to facilitate deglutition, the movement apparently straightening out the kink. Incomplete general dilatation seems to involve the thoracic portion of the œsophagus only.[4]

Fig. 1176.



General dilatation of the œsophagus; *A*, larynx; *B*, thyroid; *C*, trachea; *D*, œsophagus; *E*, stomach. (After Luschka.)

Pathology.—The entire parietes of the dilated œsophagus are usually very much thickened, often to three or more times their normal thickness. They are very vascular in some instances. The muscular coat is much the most hypertrophied, as a rule, having been found as thick as the muscles of the abdominal wall. Exceptionally it is found much atrophied,[5] although the general parietes are much thickened. The mucous membrane in some instances shows evidences of inflammation—congestive, erosive, ulcerative, or proliferative, as may be. *Annular dilatation* is most frequently the result of circumferential distention by retained aliment just above a stricture. Such a dilatation rarely occupies more than three inches of the length of the canal, and may be almost unnoticeable if not sought for. The upper portion is more distended than the lower. The canal is usually uniform in circumference, but sometimes the dilatation is most pronounced at some portion of the periphery, occasionally to such an extent as to form a diverticulum.[6] The muscular tissue above the stricture undergoes hypertrophy, and the connective tissue and mucous membrane become thickened. When due to stricture, the most frequent seat of the dilatation is where the œsophagus is crossed by the left bronchus;[1] but when not due to stricture its seat is usually just above the diaphragm. The *pouch-like dilatation*, *diverticulum*, or *sacculation*, is most frequently a pharyngeal diverticulum reaching down behind the œsophagus (*pressure diverticulum*, Zenker and Ziemssen). These cases cannot be very rare, although some forty only appear to be on record,[2] for several have been seen in my own practice. The formations appear to be single only, as a rule.[3] They are usually located posteriorly, sometimes in the median line, sometimes on one side of it. They are attributed to pressure from above, due to retention of food which gradually distends and elongates them. They vary in size from the dimensions of a pea to that of a duck's egg. True œsophageal diverticula (*traction diverticula*, Zenker and Ziemssen) are attributed chiefly to traction on

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[1] Rokitansky, Manual of Pathological Anatomy, vol. ii. p. 8. London, 1849.

[2] Luschka, Arch. f. Anat., Marz, 1868, S. 473.

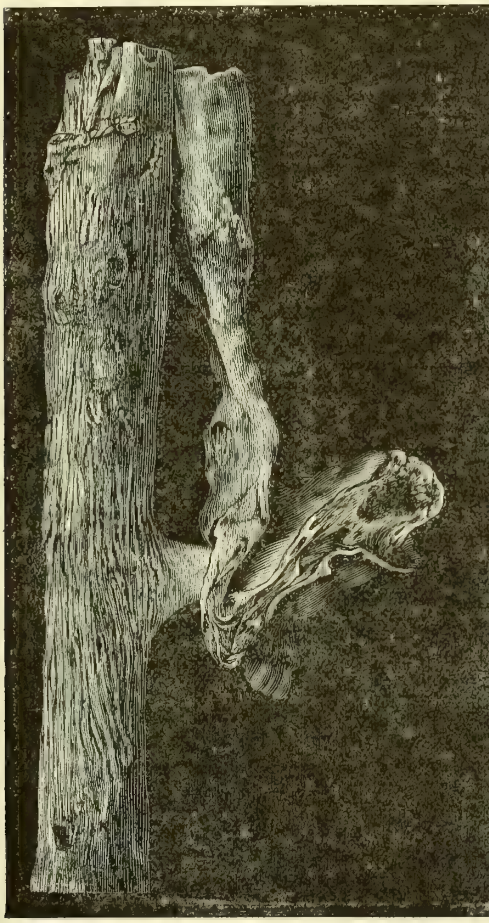
[3] Gradenwitz, Schmidt's Jahrb., Bd. ci., S. 298. 1859 (cited by Mackenzie); Davy, Dublin Hospital Gazette, May 1, 1875 (cited by Knott).

[4] Cases of Raymond (Gaz. Méd. de Paris, No. 7, 1869), and of Hanney (Edin. Med. and Surg. Jour., July, 1833).

[5] Hanney, loc. cit.

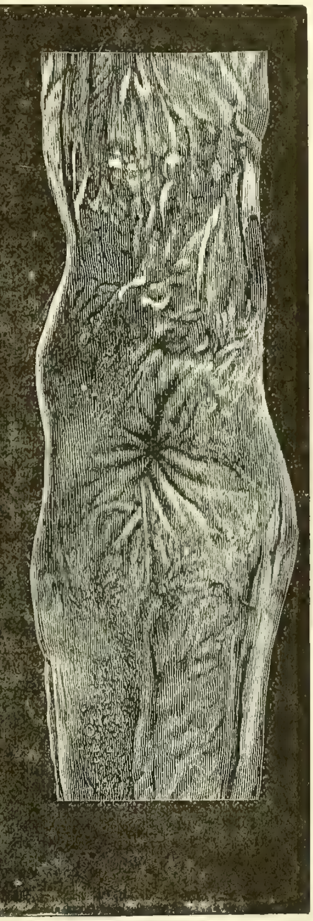
[6] Nicoladini, Wien. med. Woch. 1877, No. 25; cited by Zenker and Ziemssen.

Fig. 1177.



Traction diverticulum. Apex held fast by contracted glands to the bifurcation of the trachea. (After Zenker and Ziemssen.)

Fig. 1178.



Interior view of a traction diverticulum, to exhibit the orifice. (After Zenker and Ziemssen.)

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[1] Laborde, Compte Rendu de la Soc. de Biologie, p. 43, 1853; cited by Michel.

[2] Most of these are cited by Zenker and Ziemssen (op. cit., vol. viii. p. 52).

[3] Littrè observed four cylindrical sacs in one instance. Collection Académique, t. iv. p. 371; cited by Mondière (Arch. Gén de Méd., Sept. 1833, p. 52).

the anterior walls, after inflammatory adhesion to outside tissues, caused usually by the subsidence of tumefied lymphatic glands, which in shrinking draw the side of the tube into a funnel-shaped sac, constricted at its margin by recession of the muscular coat.[1] A case in which the apex of the sac was thus agglutinated to the trachea at its bifurcation, is illustrated by Zenker and Ziemssen.[2] (Fig. 1177.) Such diverticula are most frequent at this point, and are rarely found at any considerable distance therefrom. They are rarely deeper than from 9 to 12 millimetres, and are usually less than 8. The orifice is round or elliptic, and variable in size. (Fig. 1178.) Other diverticula have been attributed to hernia-like protrusions of the mucous membrane through ruptures of the muscular coat, sustained by falls or blows, or by violent efforts of deglutition. They have likewise been attributed to strictures of carcinomatous,[3] and perhaps of other origin. When low down, such a diverticulum may overlap the orifice of the stomach in such a way as to prevent the entrance of food.[4]

Etiology.—General dilatation may be congenital.[5] A number of reported cases are apparently congenital, there having been no stricture below them to favor mechanical distention.[6] Other instances are apparently due to mechanical distention the result of constriction at the cardia.[7] The lesion has been attributed by observers to blows on the chest,[8] to lifting heavy weights,[9] to detention of a hot solid bolus,[10] to gastric fever,[11] to distention by large quantities of water,[12] to œsophagitis,[13] and to fatty degeneration.[14] It is not unlikely that inflammation following injury may be the starting point of the process in cases of pathological origin. It is occasionally due to stricture at the cardia in connection with stricture at the pylorus,[15] and exceptionally to stricture at the pylorus alone, with limited distensive power in the stomach.[16] Paralysis, softening, and ulceration favor dilatation from distention.

Annular dilatation is almost always due to mechanical distention above a stricture, whether congenital, cicatricial, or due to morbid growth or foreign body. Instances are on record of annular dilatation from all these sources. Carcinoma is less frequently a cause than has long been generally supposed, probably because it undergoes degeneration so soon, and thus presents less resistance to pressure. Pharyngeal diverticula are sometimes due to congenital defect, and sometimes to pressure, perhaps to both causes in most instances. This defect, according to Bardeleben and to Billroth,[17] is attributable to partial external closure of one of the branchial fissures, the internal opening remaining patent. True œsophageal diverticula are attributable to defect or rupture of the muscular coat, permitting hernia of the mucous and intermediate coats; or to external traction, the result of agglutination with swollen and inflamed tissues.

Symptoms.—The symptoms of general dilatation are impediment to the passage of food into the stomach, hyper-salivation, and regurgitation—sometimes of unaltered and sometimes of fermented food—ultimately culminating in dysphagia and aphagia. The impediment to swallowing sometimes exists from infancy to advanced maturity, or even from birth to advanced old age.[1] Hiccough occurs in some instances. Complete dilatation is believed to give rise to habits of rumination, not at all unpleasant. Annular dilatation presents the usual symptoms of stricture, to which are added regurgitation at unusually long periods after deglutition, and almost continuous escape of the fetid gases of decomposition.

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[1] Rokitansky, op. cit.

[2] Op. cit.

[3] Grisolle, Bull. de la Soc. Anat. 1832, p. 113; cited by Michel (a posterior pouch at middle portion of œsophagus).

[4] De Guise, Dissertation sur l'Anévrysme, suivie de Propositions Médicales. Paris, An. xii.; cited by Mondière (Arch. Gén. de Méd., Sept. 1833, p. 34).

[5] Zenker, Ziemssen's Cyclopædia of Pract. Med., vol. viii. p. 51 (autopsy of a seven-months child, seven days old).

[6] Cases of Hanney, Chiaje, Luschka.

[7] Cases of Lindau, Rokitansky, Wilks.

[8] Hanney, Purton.

[9] Davy.

[10] Spengler.

[11] Chiaje.

[12] Oppolzer.

[13] Stern.

[14] Klebs.

[15] Lindau, Casper's Woch., 1840, S. 356; cited by Zenker and Ziemssen.

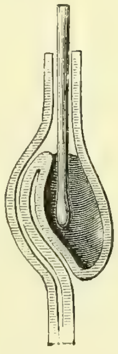
[16] Klebs, ibid.

[17] Clinical Surgery, p. 130. London, 1881.

An œsophageal diverticulum will not produce dysphagia, unless it be so situated as to compress the main channel or overlie the stomach, under which circumstances it will give rise to symptoms like those of intrinsic stricture, or of compressing stricture from tumor outside. As long as sufficient aliment reaches the stomach, nutrition remains well preserved; but when the passage of food becomes impracticable, progressive emaciation ensues, with its usual manifestations. A pharyngeal diverticulum, while filled, may so compress the œsophagus as to render deglutition impracticable, when external compression will empty part of its contents into the mouth.

Diagnosis.—Apart from the symptoms mentioned, the diagnosis will depend upon the results of auscultation of the bolus and exploration with the sound. In general dilatation, auscultation indicates too rapid a descent of the mouthful of water and in a larger stream than usual. A diverticulum, it is claimed, can be detected by the deviation of the sound from the usual line. Palpation with the bougie, in general dilatation, reveals a large sac in which the end of the instrument is freely movable. In exploring for pharyngeal sacculation, the sound may slip by the entrance of a diverticulum, especially when the latter is empty (Fig. 1179, *B*); consequently the unhindered passage of the instrument into the stomach is not positive evidence that sacculation is not present. Temporary external swelling by filling of the the sac, and its partial discharge by external upward compression, will indicate the existence of a pharyngeal diverticulum.

Fig. 1179.



A, direction of sound when the diverticulum is full. B, when it is empty. (After Zenker and Ziemssen.)

Prognosis.—The prognosis is unfavorable as to remedying the lesion. Neither medicine nor surgery is of much avail. The prognosis as to life is not unfavorable under ordinary conditions. Many years may elapse before the fatal termination takes place, whether by accidents of perforation and ulceration, or by inanition. Extreme old age has been reached by subjects who presented evidence of the lesion from infancy. When inter-current disease or consecutive lesion does not terminate life, death eventually ensues by starvation.

Treatment.—Surgery offers little in the way of remedy. Chronic œsophagitis, stricture, foreign body, or whatever may be the apparent cause, requires appropriate treatment. Feeding through a stomach-tube, well introduced, would prevent detention of food in a sac or diverticulum. Paralysis would indicate the medicinal use of phosphorus and of strychnine. The use of the stomach-tube for feeding, and of electrization for attempted cure, has been suggested for general dilatation, but the prospects of good results from electricity are hardly sufficient to justify the risk of injury by undue excitation of the pneumogastric nerve. Exsection of a pharyngeal diverticulum, through the external wound of pharyngotomy or œsophagotomy, has been suggested as a feasible operation, but I am unaware of any instance in which this operation has been attempted.

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[1] Cassan, Arch. Gén. de Méd., 2e série, t. ii. p. 79. 1836; cited by Michel (pharyngocele in a male patient, who died at 77).

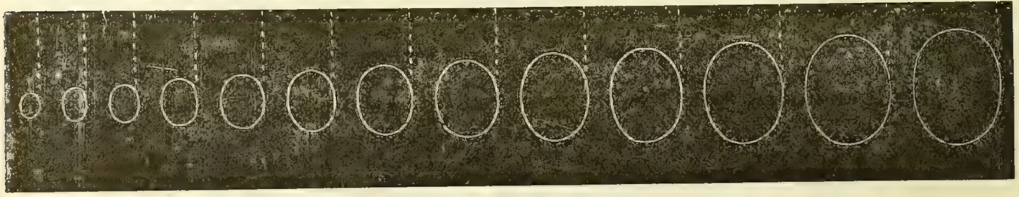
Œsophageal Instruments.

Introduction of the Stomach-Tube.—The patient should be in the sitting position, with the head bent back and supported upon the breast of the surgeon, or of an assistant, in such a direction as to bring the mouth and pharynx as much as possible in line with the œsophagus; or the recumbent position may be adopted, with the head hanging down beyond the edge of the couch or table, and supported in the hands of an assistant. The tube, previously warmed by friction or by hot water, and then lubricated with vaseline, glycerine, ointment, or oil, is next taken in one hand, while with the index or middle finger of the other, the surgeon directs the instrument beyond the epiglottis, or into one of the sinuses between the larynx and pharynx, and then gently presses it down into the œsophagus, the patient, if conscious, making voluntary efforts to swallow its extremity. Should resistance from spasmodic contraction be felt, the tube should be held in position for a few moments, and should be pushed onward at the first sign of relaxation of the spasm. The tube should then be passed down until its extremity has entered the stomach, the average distance of which from the teeth is about twelve inches in the full-grown adult.

In the presence of actual or threatened softening or ulceration, the possibility of perforation or rupture from frequent introduction of the tube is to be apprehended. Under these conditions it is preferable to keep the instrument continuously in position, for which purpose a soft-rubber or other flexible tube is used, of no greater calibre than can be passed through the nose. When the end of the tube reaches the pharynx, it is directed into the œsophagus by the fingers of the surgeon's unengaged hand. The free extremity is secured by threads and adhesive strips, or bandages, to the ear or top of the head, and is kept occluded by cork or string when not in immediate use. Krishaber has reported four cases[1] in which a soft-rubber tube, passed through the naris, was safely retained in position for periods varying from forty-six to three hundred and five days, for the latter period in a case of carcinoma.

Bougies and Dilators.—Various forms of bougie are used for the purpose of detecting and dilating strictures. They are introduced in the same manner as the stomach-tube. Bougies similar to those used in dilating urethral strictures, but of larger size, are much employed, some of equal calibre throughout,

Fig. 1180.



Sectional outlines of Mackenzie's bougie.

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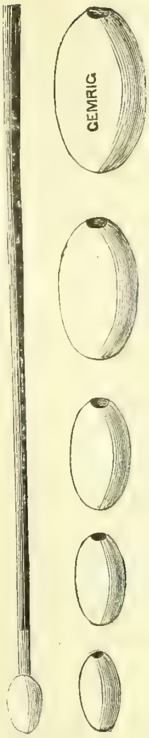
[1] Trans. Int. Med. Congress, vol. ii. p. 392. London, 1881.

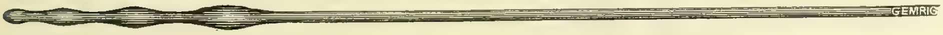
some with attenuated or rat-tail extremities. These are usually cylindrical. As remarked by Mackenzie, however, inasmuch as the transverse diameter of the œsophagus exceeds its antero-posterior diameter, bougies constructed upon that model (Fig. 1180) ought to be better theoretically; and Mackenzie has found his views confirmed by experience. Whalebone stems with ivory knobs (Fig. 1181) are also much used. The knobs should be much more tapering at the top than those usually made, so as to present less difficulty in disengaging them from beneath a stricture. The knobs should be securely fastened, and the fastening should be thoroughly tested each time that they are used, lest they should be accidentally detached in withdrawal. Ivory and metallic knobs are sometimes so arranged as to be screwed at will upon the guiding rod, a method of fastening much more secure than glueing or riveting. The safest instrument by far is the graduated œsophageal dilator of Trousseau (Fig. 1182), made of catheter material or of whalebone. It permits testing the capacity of the stricture, and systematic dilatation, without change of instrument. Dilating machines, constructed of split metallic sounds, the sides of which can be separated mechanically by the action of a screw at the free extremity, have been employed by some surgeons. It is questionable whether they are safe instruments. Another mode of dilatation which may be mentioned, consists in using a thin rubber tube which is passed through the stricture by the aid of a rigid conductor, on the withdrawal of which the tube is to be distended with compressed air, with water, or with mercury.

Fig. 1181.



Œsophageal dilators.

Fig. 1182.



Graduated œsophageal dilator of Trousseau.

Operations on the Œsophagus.

Œsophagotomy and Œsophagostomy.—Three operations are included under this head: (1) An incision from the exterior through the entire parietes of the œsophagus, for the purpose of reaching its interior to remove a foreign body, etc. (*external œsophagotomy*), or to establish a fistula (*œsophagostomy*); (2) a nick or an incision through cicatricial or diseased tissue, or through the mucous membrane and as little deeper tissue as possible, by means of an instrument passed through the mouth, for the purpose of permanently enlarging the constricted calibre of the gullet, or for facilitating subsequent dilatation (*internal œsophagotomy*); and (3) a procedure in which the external wound is utilized to afford access to a cutting instrument within the œsophagus (*combined œsophagotomy*).

(1) *External Œsophagotomy.*—Although suggested as early as 1643,[1] and successfully performed as early as 1738,[2] this operation, through lack of experience with it, was long avoided by surgeons, owing to an erroneous impression as to the difficulty of its execution and its unfavorable prognosis. More recent experiences having happily reversed this opinion, it is acknowledged as a legitimate resource of surgery under circumstances indicating its performance. In fact, during the last thirty years very few deaths have been reported after œsophagotomy for foreign body. When practicable, it is regarded as the safer procedure to perform external œsophagotomy with the aid of a guide, passed in by the mouth and pressed against the tube so that it can be felt externally. When such a guide is ready-furnished by an impacted foreign body, it is customary to cut down upon it whether on the right side or on the left. Under other circumstances the left side is preferred as the most accessible. Special sounds or conductors, to be passed through the mouth, have been devised as guides for the incision, some armed with a projectible lance to pierce the tissues through to the outside,[3] and some armed with projectible levers to push the wall forcibly forwards;[4] but a lithotomy staff, or an ordinary metallic or even a flexible bougie, answers the purpose. The point of election for œsophagotomy is the region comprised between the superior and inferior thyroid arteries,[5] which may be reached as follows—practically the method described by Guattani,[6] with such modifications as experience has dictated:—[7]

The patient is laid in the recumbent posture with the shoulders and thorax somewhat elevated, the head being slightly bent backward, and being turned toward the right when the incision is to be made on the left. The integumentary incision is best made along the anterior border of the sterno-mastoid muscle (Richerand), to the inner side, although the incision preferred by some operators is one parallel with the trachea (Bégin). Its length should comprise the space from the superior margin of the thyroid cartilage to within an inch or less of the sterno-clavicular articulation. In œsophagotomy for a prominent foreign body, the central portion of the incision is usually made right over the body. The superficial cervical fascia and the platysma being next divided, any veins requiring section are to be secured with double ligatures before they are severed, and the dissection is then to be continued, with blunt instruments as much as practicable, through the layers of fascia until the border of the sterno-mastoid muscle is exposed. The tension of the parts is then to be relaxed by raising the head slightly, and the edge of the sterno-mastoid muscle is pulled outward and backward with sharp double hooks, so as to expose the common carotid artery and accompanying nerves, which are visible through the middle cervical fascia. This fascia is next to be divided longitudinally, and drawn outward and backward with strong hooks, when the carotid artery may be expected to slip beyond the field of operation to the outside. The omo-hyoid muscle, which crosses the track of the incision at the upper portion of the wound, if in the way, is to be pulled aside, or, if requisite, is to be divided (Bégin) near the hyoid bone, so as to avoid the descending branch of the hypoglossal nerve which crosses its central portion (Michel).

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[1] Verduc, Pathologie Chirurgicale, t. ii. p. 857. 1643; cited by Terrier.

[2] By Goursauld (Mém. de l'Acad. Royale de Chirurgie, t. iii. p. 10. Paris, 1819; cited by Terrier).

[3] Sonde-à-dard of Frère Côme, referred to by Giraud, Vignardonne, and others.

[4] Ectopœsophage of Vacca Berlinghieri (Della Esofagotomia. Pisa, 1820; cited by Michel and others).

[5] Vacca Berlinghieri, op cit.

[6] Mémoires de l'Acad. Royale de Chirurgie, t. iii. p. 351. Paris, 1747.

[7] Bégin, Arnott, Langenbeck, Cheever, and others.

The vessels and nerves being now drawn to the outside, if in the track, and the larynx being drawn to the inside with sharp hooks, the layers of the deep cervical fascia are to be divided along the outer edge of the sterno-thyroid muscle; and then the capsule or inclosing fascia of the thyroid gland is to be opened, if a lobe of that gland be in the way. The loosened lobe of the thyroid gland is next to be drawn upward and inward, so as to expose the trachea, beneath which the œsophagus will be visible at the point of election for incision, between the course of the superior and inferior thyroid arteries. Should either of these vessels cross the proposed line of incision, it should be secured between two ligatures before it is divided, as, indeed, should every vessel likely to afford hemorrhage, that may be encountered. The healthy œsophagus is usually easily recognized by its position and appearance. If a guide is to be used, it is now introduced by the mouth in such a manner that the convex portion shall push the œsophagus in the desired direction. If no guide be used, the wall of the œsophagus is to be carefully raised between two pairs of forceps (Bell), and then opened at some little distance from its junction with the trachea, by a series of dissecting nicks in the longitudinal direction,[1] until the point of the knife has penetrated to the interior, when the incision is to be enlarged sufficiently to permit the introduction of the finger, or to a greater extent if necessary for the purpose in view. If the œsophagus is to be opened upon a conductor, or upon a salient foreign body, its exposed wall can be incised in a single movement. Serious hemorrhage is not to be apprehended, even though the thyroid arteries be wounded.[2] Indeed, the operation is often done without occasion to tie any vessel. Injury of the recurrent laryngeal nerve has been suspected in two cases attended by impairment of the voice.[3]

Should suturing be practised when the œsophageal wound is not to be kept open, it is deemed best to unite the edges of the mucous membrane only, sutures through both muscular structure and mucous membrane being liable to be torn out by traction produced by efforts at deglutition. Some surgeons suture the muscular coat and mucous membrane separately, but most cases have done well without any attempt to close the deeper wound at all. The edges of the integumentary incision are to be united at its upper part only, so that there may be due egress for any matters which may ooze from the wound in the œsophagus. The patient is to be nourished by enemata for forty-eight hours or more, and then, if practicable, for a few days by means of a tube passed beyond the opening, whether introduced through the mouth at intervals, or whether introduced through the nose and retained in position until the œsophageal wound has undergone cicatrization. Liquid nourishment, it appears, can, from the first, be safely given by the mouth, even although portions escape by the wound. External support by a compress during deglutition, reduces this escape to a minimum. Cicatrization may be expected between a fortnight and a month, as a rule, but sometimes it is delayed until the end of two or even three months. If the wound is to be converted into a permanent fistula for feeding (*œsophagostomy*), a soft tube may be introduced and may be retained by threads or strips. Some care is requisite in inserting tubes. In a case operated upon by me at the *clinique* of the Jefferson Medical College, for syphilitic stricture at the top of the œsophagus, such a tube had been safely introduced; but an attempt by a skilled surgeon, who was assisting, to substitute a rigid stomach-tube, eventuated in his missing the opening and passing the tube into the mediastinum; an accident undiscovered until after the death of the patient on the following day.

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[1] Bell, Institutes of Surgery, vol. ii. p. 301. London, 1838.

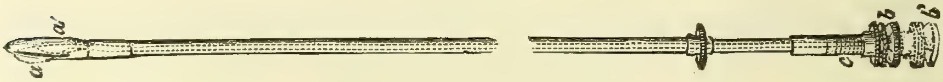
[2] The superior artery was wounded in the cases of Bégin, Cock, Arnold, De Lavacherie, and Sonrier, and in one of Cheever's; and the inferior artery in one of Cheever's (Michel) and one of McLean's. (McLean, Successful Œsophagotomy for the Removal of Foreign Bodies. Troy, 1884.)

[3] Cock, Guy's Hospital Reports, 3d series, vol. iv. p. 217; and vol. xiii. p. 1.

Œsophagotomy *for the removal of foreign bodies* appears to have been practised, according to Dr. Ashhurst's statistics,[1] in 65 cases, of which 52 are said to have ended in recovery. The same writer has tabulated 36 cases of *œsophagostomy*,[2] of which at least 27 proved fatal, one of these, however, having been subjected to gastrostomy as well.

(2) *Internal Œsophagotomy.*—This operation, similarly to the analogous operation of internal urethrotomy, contemplates nicking or cutting into cicatricial tissues by means of a scarificator concealed in a canulated tube—an *œsophagotome*—introduced into the œsophagus. The first two operations, it appears, were performed by Maisonneuve in 1861,[3] at intervals of but four days, and since that period similar procedures have been practised in some eighteen or more instances. This operation is regarded as unnecessary by some surgeons,[4] who believe dilatation practicable in any instance permitting the passage of an œsophagotome through a stricture; as inefficient, because of the frequent failure to overcome the stricture, and the necessity for repeated operations and systematic or continuous dilatation afterwards; and as hazardous, because of the risk of penetrating the œsophagus, and of dividing large or enlarged bloodvessels. For these reasons internal œsophagotomy has not received the general sanction of the profession. I have no personal experience with it. The operation is performed with an œsophagotome (Fig. 1183), consisting of a tube, carrying a wire, to which is attached a knife which can be protruded at will. Some instruments are single-bladed and some are double-bladed. The curved tube being passed beyond the stricture, the knife is projected so that it cuts through the tissues as the entire instrument is withdrawn. One or several incisions are made before the instrument is removed. Repetitions of the operation are practised from time to time, until dilatation by bougies seems practicable without it. When the œsophagotome cannot be passed through the stricture, it is sometimes made to cut its way through. This procedure is deemed dangerous even by those who commend the instrument. Twenty recorded cases of internal œsophagotomy appear to have afforded fourteen more or less permanent recoveries and six deaths.[5]

Fig. 1183.



Mackenzie's œsophagotome.

(3) *Combined Œsophagotomy.*—External œsophagotomy having been practised, the stricture is divided from the inside. Gussenbauer,[6] who named the procedure "combined œsophagotomy,"[7] and who performed the first two operations,[8] used a herniotome passed upon a grooved director; Von Bergmann used a tenotome; Sands[9] a probe-pointed eye-knife. The first three

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[1] Op. cit.

[2] Ibid.

[3] Clinique Chirurgicale, t. ii. p. 409. Paris, 1864.

[4] Campbell.

[5] Ashhurst, op. cit.

[6] Zeitschrift für Heilkunde, Bd. iv. S. 33, 20 Marz, 1883.

[7] Deutsche med. Woch., 24 Oct. 1883.

[8] Ogston, of Aberdeen, had previously supplemented ordinary œsophagostomy by dividing the stricture on a grooved director; his patient died from hemorrhage on the sixteenth day.

[9] Med. News, May 24, 1884, p. 629.

patients were doing well 14 months, 12 months, and 3 months respectively after the operation. The fistulæ were allowed to heal spontaneously, a process occupying 3 months in a female 26 years of age, 35 days in a child of 2½ years, and 5 weeks in the adult operated upon by Bergmann. Sands's patient, a child 2 years of age, died on the second day, having failed in her exhausted condition to rally from the operation. A boy, 13 years of age, who was ineffectually subjected to the same operation in the same hospital,[1] died on the twelfth day, gastrostomy having been performed nine days previously.

Gastrotomic Dilatation of the Œsophagus.—This operation, said to have been first suggested by Schede, and unsuccessfully attempted by Trendelenburg, consists in a forcible dilatation of the gullet, through a wound made into the stomach. It is done with the finger, with the bougie, or by rupture with a divulsing instrument.

In 1883, Bergmann[2] succeeded in restoring the calibre of the œsophagus sufficiently to justify closure of the gastric fistula, in a patient who had been subjected to gastrostomy, and in whom constant escape of the contents of the stomach could not be prevented. A band of membrane was made to slough out between the blades of a compressor, which had been guided to the obstruction by its grasp upon the end of a sound passed through the mouth. Five months after closure of the fistula, the stricture permitted the passage of a full-sized stomach-tube, and the patient was doing well, although dilatation was still kept up. A similar procedure, after preliminary gastrotomy, has been performed several times by Loreta.[3] Three patients are reported to have been doing well three weeks after the operation, the gastric and abdominal wounds having been closed with sutures after the divulsion of the lower portion of the œsophagus. In one case the patient swallowed easily on the first day, and was regarded as cured by the fourteenth.[4] A fourth case was operated upon for a stricture at the cardia,[5] the patient, a woman, being still living at the expiration of 25 days. Several additional cases, mostly successful, are attributed to Loreta, Studegard, Frattini, Catani, and Billroth. Loreta has in three cases successfully stretched both cardiac and pyloric orifices in the same patient.

Œsophagectomy.—Œsophagectomy is the removal of a complete section of the œsophagus, the lower end of which is then attached to the external wound. A patient thus operated upon by Czerny[6] was reported as comfortable five months after the operation. One operated upon by Von Bergmann[7] died within twenty-four hours from suppurative inflammation in the mediastinum, with pericarditis, pleurisy, and pneumonia. A patient of Novaro's,[8] from whose œsophagus two and four-fifths inches were removed, was reported as doing well seven weeks subsequently, the fistula having been closed by a plastic procedure one month after the operation. One operated upon by Israel[9] died on the seventh day from suppurative inflammation of the connective tissue of the neck, with pneumonia. Twelve cases referred to by Dr. Ashhurst[10] gave eight deaths.

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[1] Sands, loc. cit.

[2] Deutsche med. Woch., 24 Oct. 1883.

[3] Gazzetta degli Ospitali, 14 Nov. 1883.

[4] Loreta, Gaz. Med. Lomb., 24 Nov. 1883.

[5] On March 15, 1884; cited by Gross (Am. Journ. Med. Sci., July, 1884).

[6] 1879.

[7] 1883.

[8] Gazz. degli Ospitali, 9 Dicemb. 1883; Med. News, Jan. 26, 1884, p. 98.

[9] Gross, loc cit.

[10] Op. cit.

GASTROSTOMY AND ENTEROSTOMY.

GASTROSTOMY, the formation of a gastric fistula by surgical operation, for the purpose of introducing nutriment when the œsophagus is occluded, was first performed Nov. 13, 1849, by Sédillot, who named the procedure *gastrostomie;* but the operation had already been suggested by Egeberg, in 1837.[1] It is indicated in stricture of the œsophagus, impassable or rapidly becoming impassable, whether cicatricial or carcinomatous in origin. In carcinomatous cases it prolongs life and circumvents death by starvation. In cicatricial cases it may save life. I have no familiarity with the operation on the living subject.

In a tabulation of 108 gastrostomies for carcinomatous œsophagus,[2] 58 of the patients are recorded as having died within one week, 37 as having perished between the beginning of the seventh and the end of the eleventh week, 3 as having lived for three months, 4 for four months, 3 for six months, 1 for seven months, and 2 for eight months. In a later analysis of 167 cases,[3] 117 patients are said to have died within one month, and 46 to have lived for periods varying from five weeks to thirteen months; in the most successful case, a patient of Mr. Walter Whitehead, of Manchester, was in good health at the end of the thirteenth month.[4] The average duration of life in these 167 cases is given at thirty-three days. Of 37 gastrostomies for cicatricial stricture analyzed by Gross,[5] 20 terminated fatally within one month, 1 in two months, 1 in five months, 2 in seven months, 1 in ten months, 1 in eighteen and a half months, 1 in thirty-six months, 1 in forty-two months, and 1 in forty-eight months, while several patients were still living at the end of four and a half, five, eight, ten, forty, fifty-three, and fifty-six[6] months respectively, the average duration of life having been two hundred and ninety-five days. The danger of death from peritonitis is no longer as great as formerly. The first 28 gastrostomies for carcinoma terminated fatally at an early date from peritonitis or causes incident to the operation. In the twenty-ninth case[7] the patient escaped peritonitis, lived forty days, and died of bronchitis. Since this period success has been proportionately greater and greater, the operation now being undertaken at a much earlier period than formerly, and before the system has become so much reduced as to preclude recovery.

Gastrostomy may be performed in one operation or in two.[8] In the latter and preferable mode of procedure, the initial operation consists in exposing the stomach, as close as possible to its cardiac extremity, and attaching it by sutures to the abdominal walls; and the second consists in incising the viscus a few days subsequently, after the adhesions have become firm or complete. Anæsthesia and antisepsis are recommended for the initial operation.

To expose the stomach, some surgeons prefer a longitudinal incision of three or four inches in length, along the line of the linea semilunaris, but general preference has been expressed for an equivalent incision, parallel to the left false ribs, and placed one centimetre (nearly half an inch) to their inner side; the lower end of the incision reaches to the level of the bases of the cartilages of the ninth ribs, the highest point, according to Labbé,[9] at which the stomach is ever found in the cadaver. The cardiac extremity, as the fixed point of the stomach, is the guide that is wanted. All bleeding vessels should be secured immediately after division. The exposed peritoneum is to be punctured, and incised on a director to the full extent of the superjacent wound. Continental surgeons prefer short incisions. If the integumentary incision is no longer than four centimetres, it is said that the fibres of the rectus abdominis muscle[1] are not encountered, and that the stomach is exposed at about what might be called the junction of its cardiac and iliac portions—probably the best point, for the cardiac extremity is inaccessible through the approved incisions. Great difficulty may be encountered in finding and recognizing the stomach. The colon has been known to have been opened in mistake. The viscus is sometimes contracted from comparative disuse, and its walls may be in close apposition. Indeed, post-mortem examinations have shown the stomach opened at points quite different from those designed—even close to the pylorus; but it does not appear that this has been a matter of much importance in the history of the case. The stomach should be picked up with forceps. Surgeons vary in the methods of securing the stomach to the abdominal walls. Some, with Langenbeck, pass a needle twelve centimetres in length through the abdominal wall, at about two centimetres' distance from the left of the integumentary incision, then through the coats of the stomach into the viscus, and out again through the stomach, the peritoneum, and the abdominal wall on the right side of the incision. The exposed portion of the stomach is then stitched circularly to the edges of the integumentary wound, with numerous sutures, catgut or silk, or both. The fixation needle is removed in twenty-four hours, and the opening is made into the stomach on the fourth or fifth day. Some, like Albert, secure the stomach with numerous small sutures which are passed merely through the superficial coat of the viscus, and are stitched to the parietal peritoneum without any additional means of fixation. This plan is said to suffice admirably, and to be without any risk of rupture of stitches or escape of contents into the peritoneal sac. Some[2] prefer the quill suture; some, and the majority, two rows of sutures;[3] some, four deep and six or eight superficial sutures.[4] It is considered essential that from one-quarter to one-third of an inch of stomach surface should be brought into contact with the abdominal wall. The insertion into the exposed portion of the stomach of two guide-loops (Bryant) is recommended[5] to facilitate the subsequent incision into the organ.

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[1] Albert, Lehrbuch der Chirurgie und Operationslehre, Bd. iii. S. 366. Wien und Leipzig, 1882.

[2] Blum, Arch. Gén. de Méd., Nov. 1883.

[3] Gross, loc. cit., p. 53.

[4] Private communication; and Gross (loc. cit.).

[5] Loc. cit., p. 63.

[6] This is the case of Dr. Herff, of San Antonio, now of nearly six years' duration.

[7] Sydney Jones, Lancet, May 15, 1875.

[8] Howse.

[9] Albert, op. cit., Bd. iii. S. 369.

Opening the Stomach.—When it is absolutely necessary to open the stomach without delay, so as to attempt the immediate rescue of a starving patient, the stomach can be drawn forward and secured to the external wound by numerous superficial sutures, and can then be opened by a minute longitudinal or oblique incision, admitting the introduction of a canula which fits so closely that, when it is secured in place, nothing can escape by its side. A canula with a plate like that of a tracheotomy-tube, but all in one piece, can, it is claimed,[6] be very securely fastened by bandages and adhesive strips. This canula should be provided with stopcock, stopper, or obturator, to prevent escape of the contents of the stomach. When delay is permissible, the safer plan, by far, is to wait four or five days until the stomach has become agglutinated to the external wound, and then to make a longitudinal incision into it, of about one-eighth of an inch in length, to receive the tube intended to be used for feeding purposes. Some surgeons prefer to puncture the stomach with a small tenotome, making an aperture only large enough to admit a No. 10 (French) catheter.[1] In Whitehead's case[2] (Fig. 1184), the most successful on record, the puncture was made with a trocar about the size of a No. 3 (English) catheter, and a No. 2 catheter was introduced through the canula previous to its withdrawal. The catheter was retained in the stomach, but the gastric fistula was not used for feeding until a fortnight afterward. Some patients are able to eat and drink a little after the operation.

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[1] Albert, op. cit., S. 369.

[2] Bryant, op. cit., p. 467.

[3] Howse.

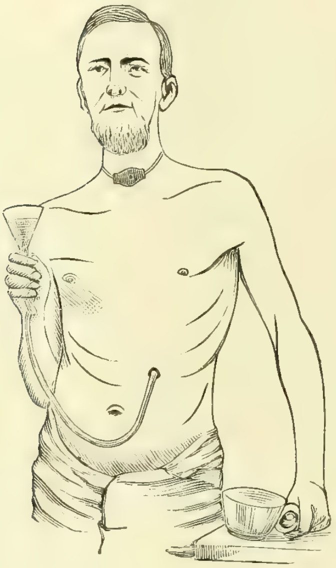
[4] MacCormac, Brit. Med. Journal, August 2, 1884.

[5] MacCormac, loc. cit.

[6] Albert, op. cit.

In several instances,[3] remarkable improvement in swallowing seems to have followed even the initial operation of exposing the stomach; possibly by reflex relaxation of the tighter spastic constriction excited in so many cases of organic stricture. In one of MacCormac's cases the stomach was not opened until the end of the second week, and the patient survived 100 days; in another, not until seven weeks, and the patient survived twenty-four weeks. One patient, mentioned by Bryant, found suddenly, two years and a half after the operation, that she could not only swallow fluids, but likewise such solids as bread, fish, and mince-meat. Mr. Bryant advised her against an operation for obliteration of the fistula, inasmuch as the external tissues remained quite dry even after a large meal. Patients as a rule become reconciled to being fed through the gastric fistula. One patient, however, voluntarily gave it up, and perished by starvation.[4]

Fig. 1184.



Method of feeding through a gastric fistula. Whitehead's tracheotomized and gastrostomized patient. (From a photograph.)

The method of feeding through the fistula varies with the character of the case, the resources of the surgeon, and the whims of the patient. A tube of some kind is to be introduced, and so arranged as to act as an obturator during the intervals between feeding times. Some practitioners begin to introduce food through the tube from the first. Others prefer to wait a day or two, to accustom the stomach to the presence of the tube, if the patient can at all be nourished by enemata. At first milk is given, a few drachms at a time, a quart or so in the twenty-four hours if tolerated. This amount is subsequently increased, and eggs perhaps added, or Leube's peptonized meat solution, and finally considerable latitude is permitted according to the desires of the patient. Some patients prefer to chew their food and then force it through the tube by means of a funnel, with digital compression, a method which, they say,[5] satisfies the mouth's hunger as well as that of the stomach.

Large quantities of food are sometimes given by the fistula, as in the case of a patient of Langenbeck's,[6] who consumed thrice daily 1500 grammes of milk, 8 raw eggs, and a spoonful of Leube's solution. The advantage of using masticated food is that the saliva is utilized. The manner in which the introduction of food is accomplished is shown in the accompanying illustration of Whitehead's well-nourished, tracheotomized, gastrostomic patient. (Fig. 1184.)

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[1] Bryant, Lancet, 1882.

[2] Brit. Med. Jour., vol. i. p. 133. 1882.

[3] MacCormac, loc. cit., p. 223.

[4] Albert, op. cit., S. 367.

[5] Langenbeck, case cited by Albert (op. cit., S. 366).

[6] Ibid.

ENTEROSTOMY.—When gastrostomy is found to be impracticable on account of participation of the stomach in the carcinomatous disease, it has been proposed to make the fistula in the duodenum—*duodenostomy* or *enterostomy*. Suggested by Surmay, the first operation of this character was performed by Langenbuch, who had intended to resect a carcinomatous pylorus; but on finding the disease too extensive, he stitched the duodenum to the abdominal wound, and eight days afterward formed the fistula. The patient died three days subsequently. Other cases in the hands of Surmay, Robertson, and Southam also terminated fatally. The operation of *gastro-enterostomy* has been described elsewhere.[1]

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[1] See Vol. V., page 1111, *supra*.

INTESTINAL OBSTRUCTION.

BY

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THE general subject of Obstruction of the Bowels belongs rather to the Practice of Medicine than to Surgery, and hence it is not designed, in the following pages, to do more than briefly glance at the pathology of the various lesions which may cause obstruction, considering more in detail the circumstances on which the diagnosis, and in consequence the treatment, of the several varieties must depend, and the various operative measures which surgeons employ for their attempted relief. Among the more important contributions to the literature of the subject which have appeared within the last two decades, I may especially mention the monograph of the late Dr. W. Brinton,[1] that of Leichtenstern,[2] those of Bulteau,[3] Rafinesque,[4] and Peyrot,[5] that of Mr. H. O. Thomas, of Liverpool,[6] and above all the recently published Jacksonian Prize Essay of Mr. Frederick Treves,[7] of the London Hospital, which work gives, upon the whole, the best account of this formidable condition with which I am acquainted. I would also commend to the reader a careful study of the pages devoted to this subject in the late Sir Thomas Watson's well-known lectures on the Practice of Physic—pages which for graphic eloquence of style, as well as for soundness and fulness of clinical instruction, have not been surpassed by the writings of any more recent author.

The most important division of cases of intestinal obstruction, from a clinical point of view, is into the *acute* and the *chronic:* the former are attended by symptoms of a most urgent and distressing character, run a rapid course, and, unless relieved by art, commonly terminate fatally in the course of a very few days; the latter make comparatively slow progress, present a milder train of symptoms, not unfrequently yield to treatment, or even undergo spontaneous cure, and, if they do prove fatal, do so at a much later period than the acute cases. In practice, however, instances not very seldom occur which seem to stand midway between these extremes, and may properly be called examples of *subacute* obstruction; and while acute may, as well observed by Pollock, occasionally subside into chronic cases, the latter much more frequently, at some period of their history, suddenly become acute.

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[1] On Intestinal Obstruction. London, 1867.

[2] Ziemssen's Cyclopædia of Practical Medicine, vol. vii. New York, 1876.

[3] De l'Occlusion Intestinale au Point de Vue du Diagnostic et du Traitement. Paris, 1878.

[4] Étude sur les Invaginations Intestinales Chroniques. Paris, 1878.

[5] De l'Intervention Chirurgicale dans l'Obstruction Intestinale. Paris, 1880.

[6] The Treatment of Intestinal Disease and Obstruction, 3d ed. London, 1883.

[7] Intestinal Obstruction: its Varieties, with their Pathology, Diagnosis, and Treatment. London, 1884.

ACUTE INTESTINAL OBSTRUCTION.

Apart from *strangulated hernia*, which has already been fully considered in the fifth volume of this work,[1] and need not, therefore, be again referred to, the most frequent causes of acute obstruction of the bowels are (1) *congenital malformations*, such as imperforate anus, occlusion or absence of the rectum, etc.; (2) the *impaction of foreign bodies* or abnormal *concretions*, such as gall-stones or enterolites; (3) the *invagination* or *intussusception* of one portion of bowel within another; (4) *twisting* or *knotting* of the bowel upon itself—*volvulus;* (5) *internal strangulation* by bands of organized lymph, adhesions, or diverticula, by protrusion of the gut through rents or other apertures in the mesentery or omentum, or by other forms of internal hernia; and (6) various *inflammatory affections* of the abdomen, such as peritonitis and enteritis —that is, inflammation of the serous and muscular coats of the bowel. Acute obstruction may also be rapidly superinduced in chronic cases, as of intestinal stricture, by any cause which produces sudden blocking of the bowel's whole calibre. The term "*Ileus*," formerly much used by writers on intestinal obstruction, is so indefinite that it might well be abandoned: the *ileus inflammatorius* was the affection already referred to as serous and muscular enteritis, while the name *ileus spasmodicus* or *miserere mei* was indiscriminately applied to simple colic (when violent), to volvulus, to intussusception, to internal strangulation, and in fact to all varieties of acute obstruction. That *spasm* of the bowel, without organic change, can produce obstruction, is more than doubtful; *paralysis* of the intestine, except as accompanying muscular enteritis, is rather a cause of chronic than of acute obstruction (ileus paralyticus), but *fatty degeneration* of the muscular wall is believed by Fourneaux Jordan to be a cause of both varieties.

CONGENITAL MALFORMATIONS.—These will be properly considered in the article on Injuries and Diseases of the Rectum, and it will suffice to say here that, as an imperforate anus or absent rectum cannot possibly be remedied by medicinal treatment, the surgeon should lose no time, as soon as the nature of the case is recognized, in resorting to operative measures—opening the bowel from the perineum, when that can be accomplished, and when it is impossible having recourse to colotomy, seeking the intestine preferably, I think, by Littre's method in the left groin.

IMPACTION OF FOREIGN BODIES, GALL-STONES, ENTEROLITES, ETC.—*Foreign bodies* may enter the bowels and produce obstruction either by being swallowed and passing down into the gut, by being introduced into the rectum, or by entering through the abdominal parietes, as in the case of bullets lodging in gunshot wounds. Cases illustrating each of these modes of entrance have been referred to in the article on Injuries and Diseases of the Abdomen,[2] and many others are cited in Poulet's curious treatise.[3] They may produce acute obstruction by suddenly plugging a portion of bowel already narrowed by other causes, but are more likely, by leading to ulceration and subsequent contraction, to give rise to intestinal stricture and thus lay the foundation for chronic obstruction, which may prove fatal long after their discharge either by vomiting or by defecation. *Gall-stones* are probably more often the cause of acute obstruction than foreign bodies. They are most apt, according to Leichtenstern's statistics, to lodge in the lower portion of the ileum, and next in the duodenum or jejunum; when once they have passed the ileo-cæcal valve, they meet with no further interruption until they reach the anus, when they may be arrested by the sphincter, and require instrumental aid for their expulsion. But in fatal cases of obstruction from gall-stones, the offending bodies have, according to Treves, invariably been found in the small and never in the large intestine. Gall-stones are the cause of intestinal obstruction much more frequently in women than in men—in the proportion of four to one—and are met with almost exclusively in persons past the middle period of life, the average age in 16 cases collected by Treves having been 57 years. Though of frequent occurrence, however, they rarely cause occlusion, cases of this kind forming, according to Leichtenstern's statistics, less than four per cent. of all cases of obstruction. In rare instances gall-stones may cause abscess and fistula, and the calculus may thus escape externally.

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[1] See Prof. John Wood's Article on Hernia, Vol. V. page 1115, *supra.*

[2] See Vol. V. pp. 991-994, *supra.*

[3] Treatise on Foreign Bodies in Surgical Practice, vol. i. p. 167. New York, 1880.

Enterolites, or *intestinal concretions*, are of several distinct varieties: (1) They may consist of mineral substances, chiefly phosphatic, combined with animal matter and sometimes cholesterine. These are analogous to the intestinal concretions or *bezoar-stones* found in the lower animals; (2) They may be formed by densely packed masses of vegetable substances, mingled with fecal matter and a small proportion of mineral constituents. Under this head are to be placed the *avenolites*, or "oat-stones," said by Treves to be not uncommon in Scotland, where oat-meal is a frequent article of diet, as also the concretions of starch and cocoa-nut fibres observed by Dr. Harley, Dr. Down, and others; (3) A third variety of intestinal concretion is formed by the aggregation of substances which have been swallowed, as medicines or otherwise. Among these may be mentioned carbonate of magnesium and iron (Hutchinson), chalk (Bamberger), and benzoin (Erichsen). Enterolites rarely cause obstruction—in less than two per cent. of all cases, according to Leichtenstern. They do so three times as often in men as in women, in this respect reversing the proportions of the sexes thus affected by biliary calculi.

INTUSSUSCEPTION OR INVAGINATION of the bowel is one of the most frequent causes of acute obstruction, and certainly the most frequent cause of obstruction which ends in death, no less than 43 per cent. of fatal cases, according to Brinton's statistics, and more than 38 per cent. according to Leichtenstern's more extended figures, being due to this cause. The affection is more common in the male than in the female sex, and during infancy much more common. According to Mr. Treves, one-half of all cases occur during the first ten years of life, and one-fourth during the first twelve-month. In the very large majority of cases it is the upper segment of bowel which is invaginated into the lower—as the ileum into the cæcum—though occasionally the invagination is in the opposite direction, when the case is said to be one of *retrograde intussusception*. It is right to add that in the multiple invaginations which, as is well known, often occur during the act of dying, retrograde intussusceptions are not uncommon; but the invaginations which occur during life, and which alone cause intestinal obstruction demanding the attention of the surgeon, are almost invariably direct. An intussusception embraces, of course, three layers of bowel, each involving all the coats of the gut: the external layer is called the *sheath*, or *receiving layer*—the *intussuscipiens*—while the internal or *entering layer*, and the middle or *returning layer* together constitute the *intussusceptum;* the *neck* of the intussusception is the junction of the external and middle layers, and its *apex* that of the middle and internal layers. In some cases an intussusception is found to embrace *five* layers of gut, either a second intussusceptum having been invaginated into the first, which then serves for its sheath, or the first sheath with its included intussusceptum being itself invaginated into another portion of bowel, which then forms a second sheath. These are called *double* intussusceptions, and a few cases of *triple* intussusception even are on record, there being in these no less than *seven* layers of gut.

The most frequent seat of invagination is at the ileo-cæcal junction, the cæcum turning upon itself, and with the ileum passing down into the colon, with the apex of the intussusceptum constituted by the ileo-cæcal valve (*ileo-cæcal invagination*); a much rarer variety is that named by Leichtenstern the *ileo-colic*, in which the ileum slips through the ileo-cæcal valve, and enters the colon unaccompanied by the cæcum, the apex of the intussusception being here formed by the reflexion of the ileum upon itself. Invaginations limited to the small intestine come next in frequency to the ileo-cæcal, those of the ileum being, according to Brinton, much commoner, but according to Treves much rarer, than those of the jejunum; and lastly those limited to the large intestine. I have summarized in the annexed table the percentages bearing upon this point, derived from the statistics respectively collected by Brinton, Leichtenstern,[1] and Bulteau.

TABLE SHOWING THE RELATIVE FREQUENCY OF DIFFERENT VARIETIES OF INTUSSUSCEPTION.

Author.	Ileo-cæcal and Ileo-colic.		Ileal and Jejunal.		Colic.
Brinton	56 per cent.		28 per cent.	4 per cent.	12 per cent.
Leichtenstern	44 per cent.	8 per cent.	30 per cent.		18 "
Bulteau	51.4 per cent.		28.8 "		19.8 "

It will be seen from the above figures that, in round numbers, more than one-half of all cases of intussusception occur in the ileo-cæcal region, less than one-third in the small intestine, and about one-sixth in the large bowel.

In the *progress* of an intussusception its increase is at the expense of the sheath, which continues to turn upon itself at its neck; so that an ileo-cæcal invagination, for instance, beginning of course on the *right* side of the abdomen, comes gradually, by the inversion of successive portions of colon, to form a tumor upon the *left* side, and finally may protrude at the anus. The only exception to this rule is in the case of the ileo-colic variety, in which, the ileo-cæcal valve having been passed, there is nothing, unless adhesions are formed, to restrain the ileum from continuing to slip into the colon, and in which therefore the intussusception grows by successive portions of its entering layer becoming inverted, and thus added to the returning layer, while the sheath, for a time at least, remains unchanged. As the *mesentery* is carried with the entering layer into the sheath, it drags upon the former and tends both to give the intussusception a curved—sometimes a sharply curved—outline, and to displace the orifice of the invaginated gut towards the mesenteric side of the intussuscipiens; these changes are most marked in the case of ileo-cæcal invaginations, and manifestly increase the tendency to complete occlusion. The *extent of bowel* involved in an intussusception may vary from a few inches to more than two yards.

Intussusceptions, as a rule, soon become *irreducible* from the formation of peritoneal adhesions between the serous surfaces of the entering and returning layers; these adhesions vary in firmness in different cases, are sometimes limited to the neck, more commonly perhaps unite through a considerable space the two layers of the intussusception, and are very rarely confined to the apex. Reducibility may be further interfered with by swelling, bending, or twisting of the intussusceptum, or by the pressure of a polypus.

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[1] Besides Leichtenstern's monograph in Ziemssen's Cyclopædia, already referred to, he has published an elaborate study of intussusception in the Vierteljahrschrift für die practische Heilkunde, Bd. cxviii.–cxxi.

No marked changes occur, as a rule, in the sheath of an intussusception, though ulceration from pressure, and even perforation, have occasionally been noted; the intussusceptum is apt to become strangulated and gangrenous, and then, if there are firm adhesions at the neck, a spontaneous cure may follow the separation of the dead part.

The *causes* of invagination have been experimentally investigated by Nothnagel, who describes two varieties, the spasmodic and the paralytic, the former being much the more common. The inference from his experiments, confirmed by the results of clinical observation, is that invagination follows irregular and disorderly contraction of the bowel, from whatever cause, the intussusception occurring at the expense of the normal gut, which is, as it were, drawn over the contracted part, and not being due, as is often taught, to the latter being forcibly driven into the former. Mr. Treves calls attention to the probable influence, in this process, of the longitudinal muscular fibres of the bowel, acting from the contracted portion as from a fixed point, and thus drawing the uncontracted portion over the other. Among the predisposing causes of invagination may be mentioned feeble health, diarrhœa, the presence of irritating or undigested food, intestinal polypi, strictures or tumors of the bowel, adhesions following injury, etc.

VOLVULUS.—The term *volvulus* may be used to designate two separate conditions: one, and that much the commoner, being a twisting of the gut about an axis formed by the mesentery or mesocolon (more rarely twisting of the gut upon its own axis), and the other being the intertwining or knotting together of two separate portions of intestine. Volvulus is usually associated with, and indeed dependent upon, an abnormal state of the mesentery, which consists in its elongation and relaxation, allowing the bowel to hang in a long loop with its ends comparatively close together. This elongated state of the mesentery may be sometimes congenital, but is usually acquired, and in the case of volvulus of the sigmoid flexure is no doubt often traceable to habitual constipation, leading to distension of the gut with fecal matter, which by its weight drags upon the mesocolon. The sigmoid flexure is the most frequent seat of this form of volvulus, two-thirds of all cases, according to Mr. Treves, occurring in this locality, but it is also met with in the ascending colon and cæcum, and in the small intestine. Twisting of the bowel upon its own axis appears to occur only in the cæcum and ascending colon. In the second form of volvulus (intertwining of two separate loops of bowel), it is usually the sigmoid flexure and the small intestine that are involved, but occasionally two loops of the small intestine alone.

Volvulus appears to be about four times as common in men as in women, and usually occurs in those past the middle period of life. Volvulus of the small intestine occurs at an earlier age than that of the large bowel. Volvulus soon becomes irreducible, through the formation of adhesions, and is followed by peritonitis, at first local, but soon spreading over the abdomen. It may also cause death by interference with the action of the heart and lungs from the upward pressure of the bowels, which become enormously distended.

INTERNAL STRANGULATION, next to invagination, is the most frequent cause of acute intestinal obstruction apart from strangulated hernia, 31.5 per cent. of all cases, according to Dr. Brinton, and 26 per cent., according to Leichtenstern, being of this character. Mr. Treves describes five varieties of internal strangulation, viz., (1) strangulation by isolated peritoneal adhesions (or, to use Mr. Gay's term, "by the solitary band");[1] (2) strangulation by cords formed from the omentum; (3) strangulation by Meckel's diverticulum (a diverticulum passing from the lower part of the ileum to the umbilicus, being a remnant of the vitelline duct); (4) strangulation by normal structures with abnormal attachments, such as an adherent appendix vermiformis or Fallopian tube, including strangulation by a fixed portion of the mesentery, by the pedicle of an ovarian cyst, etc.; and (5) strangulation through slits and holes in the mesentery or omentum, in certain peritoneal ligaments, or in membranous adhesions. In connection with these varieties may be mentioned certain forms of internal strangulated hernia—obturator, diaphragmatic, etc.

Strangulation by bands, cords, diverticula, etc., is usually effected by the gut passing under the band, if this is short, or being snared in a noose or knot if it is long and attached only by its extremities. In rare cases, however, strangulation has been caused by a segment of bowel being caught, and as it were suspended, *over* a tense band; and acute obstruction, without strangulation, may be caused in still other ways by bands and adhesions. Thus, as pointed out by Mr. Treves, there may be occlusion from "acute kinking" of the gut, due to traction on an isolated band, or on an adherent diverticulum; adhesions, too, may cause obstruction by compressing the intestines, by gluing several coils together, or by holding the bowel in a bent position; by the simple, long-continued traction on an adherent band or diverticulum, changes in the wall of the gut, ending perhaps in ulceration and cicatricial constriction, may be induced; and, finally, chronic peritonitis may lead to marked shrinking of the mesentery, and to secondary stenosis of the bowel. It is obvious that the latter condition would be apt to cause chronic rather than acute obstruction.

Internal strangulation is more common in the male than in the female sex in about the proportion of three to two. It is most common in early adult life, and is very rare in children. The usual seat of strangulation is the small intestine, which is affected, according to Brinton's statistics, in 95 per cent., and according to those of Bulteau in 88 per cent., of all cases.

ENTERITIS AND PERITONITIS.—These affections, the symptoms of which often very closely simulate those of acute intestinal obstruction from mechanical causes, are more appropriately considered in works on the practice of medicine than in those devoted to surgery, and I shall therefore not refer to them further than to urge the importance of the surgeon bearing in mind the possibility of their being present, and endeavoring to eliminate the doubt by careful examination and, if necessary, tentative treatment, before resorting to operative measures. By *enteritis* I mean of course the *Enteritis phlegmonodea* of Cullen, which Sir Thomas Watson has so well described, and which he characterizes as being "in most cases peritonitis, and something more." It may be caused by exposure to cold and wet, especially of the lower extremities, and particularly when the exposure follows a meal, when the digestive organs are in a state of functional activity. It may also, I believe, be caused by the use of indigestible food, and by the abuse of purgative medicines. It occurs in both sexes and at all ages, and may involve any portion of the bowel. This is, from one point of view, the most important of all forms of acute intestinal obstruction, since it is that from which recovery, under judicious treatment, may be most confidently expected.

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[1] According to Dr. Fitz's investigations (Amer. Journ. Med. Sciences, July, 1884), these bands more often originate from obliterated or patent omphalo mesenteric vessels than from adhesions following peritonitis.

Chronic Intestinal Obstruction.

Chronic obstruction of the bowels may be caused by several conditions, the most important being (1) accumulations and impactions of *fecal matter;* (2) organic *constrictions* of the bowel, whether of a fibrous or cicatricial character or due to presence of malignant growths; (3) chronic *invaginations;* (4) *inflammatory changes* in the walls of the gut, and especially in its peritoneal covering, the indirect result of external violence; (5) *chronic peritonitis*, often tuberculous in origin; and (6) the *pressure* exercised by abdominal abscesses and tumors external to the intestine.

Fecal accumulations occur most frequently in the large intestine, and particularly in the cæcum and ascending colon. When habitual constipation reaches its highest degree, a portion of the bowel loses altogether the power of peristaltic movement (*ileus paralyticus*), and fresh fecal matter being constantly pushed into the affected segment by the action of the bowel above, the distension continually increases, and ultimately rupture of some of the muscular fibres ensues, or ulcers may form (stercoral ulcers), leading to chronic peritonitis or to cicatricial constriction, or, more rarely, to perforation followed by acute peritonitis and death. Fecal accumulations are more common in women than in men, and are usually met with in those who have passed the middle period of life. They are not uncommon among the insane, and in hysterical subjects.

Stricture of the Bowel.—Intestinal stenosis may be in some cases congenital, but then, if obstruction should occur, it would probably be acute, from the sudden occlusion of the narrowed gut by a plug of fecal matter or a foreign body. Acquired constriction, which alone should receive the name of stricture, is developed gradually, and is therefore more apt to cause chronic obstruction, though it may give rise to the acute variety in the same manner as the congenital defect just referred to. In stricture of the bowel, properly so called, the parts involved are the mucous and submucous layers of the intestine, and, as already mentioned, the stricture may be fibrous or cicatricial, or due to the presence of a malignant neoplasm. *Cicatricial stricture* may result from the contraction which follows the healing of intestinal ulcers, from the changes following strangulated hernia, from those following the separation by sloughing of an invaginated portion of gut, and, possibly, from certain lesions of a traumatic character. The ulcers which are most apt to lead to the formation of stricture are the dysenteric, the catarrhal, the stercoral, and the syphilitic. The dysenteric and stercoral ulcers are met with only in the large intestine; the catarrhal and syphilitic also occur in the lesser bowel. A portion of intestine which has been involved in a strangulated hernia may become the seat of stricture, as the result of ulceration or gangrene, and, as already mentioned, stricture may possibly follow the sloughing of the intussusceptum in invagination. Stricture may also result from partial rupture of the gut as the result of external violence. *Malignant stricture* of the intestine is commonly due to the presence of a cylindrical-celled or columnar-celled carcinoma,[1] a form of tumor usually classified with the epitheliomata. It may occur in any portion of the bowel, but is most often observed in the large intestine.

The bowel above the constricted portion, in either variety of stricture, becomes much dilated and generally thickened, though immediately above the stricture a pouch is often formed, with thin walls, in which ulceration and perforation are apt to occur. Perforation is, of course, usually fatal through the development of peritonitis, but in some cases a fistulous communication is formed with the bowel below the stricture (*fistula bimucosa*), thus giving at least temporary relief. Foreign bodies, such as fruit-stones, are often found in the dilated pouches above intestinal strictures, and, by one of these foreign bodies plugging the orifice of the constricted portion, symptoms of acute obstruction may ensue; acute obstruction may also follow the formation of a secondary volvulus, or the bending, or, as Mr. Treves calls it, "kinking," of the bowel at its constricted part. On the other hand, a patient may die from intestinal stricture, gradually sinking from exhaustion, without symptoms of obstruction having been at any time observed.

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[1] See Vol. IV. p. 632, *supra;* and Plate XX. Fig. 19.

Stricture of the bowel is more common in women than in men, and usually occurs in persons over forty years of age. Cicatricial stricture is met with at an earlier age than the malignant variety. Of 26 cases of stricture of the *small intestine*, collected by Mr. Treves, 10 followed ulceration (6 in males and 4 in females); 2 were due to injury (both in males); 4 were traceable to the changes occurring in strangulated hernia (2 in either sex); and 10 (5 in either sex) resulted from carcinoma. Of 8 cases of stricture at the *ileo-cæcal valve*, 3 were examples of simple and 5 of malignant stricture, one in each category occurring in the male and the rest in the female sex. Of 44 cases involving the *colon*, 13 were of simple stricture (2 in males and 11 in females); 28 were of cancer (14 in either sex); and in 3 (2 in the male and 1 in the female sex) the nature of the constriction was unknown. The part of the colon implicated in these 44 cases, and in 54 others collected by Dr. Hilton-Fagge and by Messrs. Coupland and Morris, was the sigmoid flexure in 58, the descending colon in 11, the splenic flexure and transverse colon each in 7, the hepatic flexure in 9, the ascending colon in 2, and the cæcum in 4.

Sarcomata occasionally occur in the intestine, as do various forms of non-malignant tumor, the latter usually in the form of polypi; these do not, however, often produce obstruction, except by disposing to intussusception, in which case the occlusion is ordinarily of the acute variety.

CHRONIC INVAGINATIONS are occasionally met with, causing chronic and sometimes only incomplete obstruction. They have been particularly studied by Rafinesque, who finds[1] that of 55 cases in which the locality of the intussusception was noted, no less than 33, or 60 per cent., were of the ileo-cæcal variety, and 6, or 10 per cent., of the ileo-colic, while 8, or 15 per cent., involved the large intestine alone, and as many the small intestine separately. An important peculiarity of chronic invagination is that it comparatively seldom ends in recovery by sloughing of the intussusceptum; thus, of 124 cases of spontaneous separation tabulated by Leichtenstern, in no less than 94, or 76 per cent., was the process accomplished during the first four weeks, and in only 18, or 15 per cent., after the second month. The proportion of cases in which spontaneous separation occurs in chronic cases, as given by Rafinesque, is only 11 per cent.

TRAUMATIC CHANGES.—The occurrence of intestinal stricture as a result of injury, causing partial rupture of the bowel, has already been alluded to, but a more common mode, probably, in which external injury causes obstruction, is by setting up a chronic peritonitis, which leads to thickening of the serous coat of the bowel and perhaps adhesion of contiguous coils, thus interfering with the peristaltic motion, or which causes a shrinking of the mesentery and secondary stenosis.

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[1] Op. cit., p. 62.

Chronic Peritonitis.—Just as acute peritonitis gives rise to acute intestinal obstruction, which may sometimes be indistinguishable from that produced by mechanical causes, so may chronic peritonitis give rise to chronic obstruction. In these cases the peritonitis is often of tuberculous origin.

Pressure External to the Bowel.—Finally, chronic obstruction may be caused by sources of compression external to the intestine itself, among which may be mentioned various forms of abdominal abscess, tumors of the solid viscera, the pressure of a retroverted uterus, etc.

It must not be forgotten that in any case of chronic obstruction, acute symptoms may be suddenly developed as the result of secondary volvulus, "kinking," occlusion by gall-stones or fecal masses, or the development of enteritis.

Symptoms of Intestinal Obstruction.

It may be said, in general terms, that in *chronic* obstruction, the symptoms are mainly due to the impeded passage of the intestinal contents, or, in other words, are symptoms of obstruction merely, and that in *acute* obstruction there are superadded the symptoms of strangulation.

Symptoms of Acute Obstruction.—The most important of these are pain, abdominal tenderness, vital depression, vomiting, constipation, lessened flow of urine, tympanites, and, in cases of intussusception, the presence of a tumor.

Pain.—The pain of acute intestinal obstruction (*miserere mei*) is extreme, and often agonizing. In strangulation by a band, or in internal hernia, it commonly begins abruptly and continues without intermission, though often diminishing somewhat in severity as the case progresses; in volvulus and in intussusception, on the other hand, the pain is usually at first paroxysmal, with intervals of comparative ease, but afterwards becomes constant, though even then presenting periods of exacerbation. The pain is often referred to a particular spot in the abdomen, and in a certain number of cases this is found after death to have corresponded with the locality of the lesion. In more cases, however, the sensations of the patient upon this point are deceptive, and no direct connection can be traced between the seat of pain and the strangulated bowel. In the majority of cases, probably, the pain is referred to the neighborhood of the umbilicus (*tormina*), possibly owing, as suggested by Mr. Treves, to the fact that the solar plexus is situated a little above that position. The *cause* of the pain which accompanies acute intestinal obstruction is in the first place the direct injury to the bowel and mesentery produced by their strangulation; afterwards the violent peristalsis which ensues, and which is abruptly checked at the seat of obstruction, causes exacerbations of suffering; and, finally, additional sources of pain are the extreme distension of the gut which sometimes follows, and the development of inflammation in the bowel itself or in the peritoneum. In the early stage, the pain of acute obstruction may be somewhat relieved by pressure, but after the development of peritonitis it is aggravated by the slightest touch. A sudden cessation of pain (without the strangulation having been relieved) indicates the occurrence of collapse or gangrene.

Abdominal tenderness is usually absent in the earliest stage of acute obstruction, though in cases of simple enteritis it is present from the beginning. In volvulus and intussusception it is soon developed—in connection with inflammation of the affected part—but in strangulation by a band it may be almost entirely wanting, and death may ensue without marked tenderness having been at any time observed. Tenderness limited to a particular spot—unlike pain similarly localized—is an important symptom, as indicating the seat of obstruction. Diffuse abdominal tenderness, if slight, may be due simply to the violent peristaltic motion of the gut above the strangulated part, but if intense, it is indicative of peritonitis.

Vital Depression.—In connection with the intense pain of acute obstruction, there is commonly great prostration, commensurate with the tightness with which the bowel is strangulated. It is most marked in strangulation by a band and in internal hernia, is somewhat less in volvulus and in the more acute forms of invagination, and may be entirely absent in obstruction by gall-stones, etc., as it is, in the early stages, in chronic invagination, and in simple enteritis without mechanical occlusion.

> There is (says Mr. Treves, speaking of strangulation by bands) great muscular weakness, the face is drawn with pain, and has an aspect of horrible anxiety, the features become pinched, the eyes sunken and surrounded by bluish rings, and the voice weak and muffled. A cold sweat breaks out upon the surface, and in extreme cases the limbs become cyanosed and the complexion livid. The patient at last sinks, retaining his intelligence, as a rule, to the last.

The pulse and breathing are both rapid in acute obstruction; the former, feeble and often thread-like, and the latter superficial and chiefly effected by the subsidiary muscles of respiration. The temperature is below the normal standard (except in enteritis), and may not even rise upon the development of general peritoneal inflammation. There is great thirst, especially when there is profuse vomiting, and, when this becomes stercoraceous, the patient has a very offensive breath. Singultus is sometimes a distressing symptom.

Vomiting.—This is an early and very prominent symptom in cases of strangulation by a band or diverticulum, but much less so in those of intussusception and volvulus, until secondary enteritis is developed, when the nausea and vomiting may be very distressing. The matters first ejected—just as in cases of strangulated hernia—are the contents of the stomach, and then those of the upper bowel; finally, the vomiting may become decidedly stercoraceous in character. Occlusion of the small intestine is attended by earlier and more persistent vomiting than that of the larger bowel, but, on the other hand, the vomiting in the former case is less apt to be stercoraceous, though in some instances the contents of the lower ileum have an undoubtedly fecal character. The occurrence of stercoraceous vomiting was formerly attributed to a reversed peristaltic movement (*anti-peristalsis*) of the intestine, but though such reversed movements do undoubtedly sometimes occur, the ordinary, direct peristalsis is, when the bowel is occluded, quite sufficient for the purpose. This subject was particularly investigated by the late Dr. W. Brinton, who conclusively showed that when obstruction was present, and the gut contained fluid, the effect of the peristaltic wave was to cause a reversed upward current in the centre of the intestine, just as a piston with a median perforation, driven forwards in the cylinder of a pump, forces water backwards through its opening.

Constipation is, of course, a prominent symptom in all forms of intestinal obstruction, but it is by no means equally marked in all varieties. Absolute and persistent in cases of strangulation by a band, it is only partial in those of enteritis, and in some instances of chronic invagination has been at times entirely absent; here, indeed, as in some cases of intestinal stricture, the patient's chief complaint may be of diarrhœa. Even when complete strangulation has occurred—as in external hernia—the use of enemata may cause one or two evacuations of fecal matter accumulated below the point of obstruction. In acute intussusception the patient experiences a constant desire to go to stool—which Mr. Pollock considers almost pathognomonic—and with the tenesmus there is not unfrequently a discharge of mucus from the rectum, mingled with fluid or clotted blood.

Diminished Flow of Urine.—The amount of urine excreted is lessened in all cases of acute intestinal obstruction, and it has been maintained by Dr. Barlow and Dr. Golding Bird, as well as by Mr. Hilton, that the diminution is proportional to the proximity of the obstruction to the pylorus. Doubt has however been thrown upon this proposition by several writers, including Habershon, Leichtenstern, Sedgwick, Gay, and Treves, and it is probable that, as pointed out by the last-named surgeons, it is rather the completeness than the situation of the strangulation which determines the degree of anuria, and that the mistake has arisen from the fact that acute obstruction usually affects the small, and chronic obstruction the large intestine. The flow is measurably restored when the patient is brought fully under the influence of opium, although the obstruction be unrelieved. This is partly due to the cessation of vomiting—which, by exhausting the fluids of the system, itself tends to diminish the flow of urine—but mainly to the action of the drug on the nervous system. The symptom may be of some value, however, in cases of incomplete and chronic obstruction, the excretion being, as observed by Leichtenstern, constantly less in constrictions high up, as it is in those of the pylorus itself, but not in constrictions of the lower ileum and large intestine.

Tympanites.—This is an early and well-marked symptom in cases of volvulus, but is less prominent in other forms of intestinal obstruction, being indeed often absent unless general peritonitis is developed. The swelling in volvulus is usually at first limited to the left side (sigmoid flexure), though this rule is not without exceptions; ultimately the whole belly becomes uniformly distended. As a contrast to the tympanites of volvulus, I may refer to the so-called "signe de Dance,"[1] which consists in the presence of a marked *depression* in the *right* iliac fossa, owing to the displacement of the cæcum in cases of ilio-cæcal invagination. As pointed out by Rafinesque, this symptom may be artificially induced by inflating the rectum and lower bowel with air, and the position of an intussusception may thus sometimes be determined. Visible movements of the coils of intestine, though common in cases of chronic obstruction, are rare when the occlusion is primarily acute; hence, when observed with symptoms of acute obstruction, they indicate that the latter has been superadded to a previously existing chronic condition.

The Abdominal Tumor.—This is one of the most important symptoms in cases of intussusception, and has been noted in more than one-half of the recorded cases. It must not be confounded with the localized, tympanitic distension of volvulus, nor with the tumor produced by impacted feces; it would hardly seem necessary to say that no confusion should arise between this and the normal structures of the body, but that I have known the convexity of the lumbar vertebræ to be mistaken for an invaginated bowel. In the large majority of cases, the *tumor of intussusception* is found upon the *left* side, not attracting attention until the cæcum and ascending colon are well advanced into the transverse and descending colon. In many cases, in children especially, the tumor can be distinctly felt from the rectum. It is much more prominent during an exacerbation of pain than when the bowel is quiescent. The *tumor of fecal accumulation* is almost always found at the right side (cæcum), and, which Treves and Sawyer consider a pathognomonic sign, may often be made to pit by firm external pressure.

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[1] Named after Dance, a French surgeon, who wrote in the early part of this century.

SYMPTOMS OF CHRONIC OBSTRUCTION.—These may be conveniently considered in contrast to the symptoms of acute obstruction as already described. The *pain* in chronic obstruction is not constant as in acute occlusion, but rather paroxysmal, of a distinctly colicky character, and, if the smaller bowel be the seat of obstruction, often coming on at a definite period after eating. If the obstruction suddenly becomes complete—as by a gall-stone becoming impacted in an intestinal stricture—the character of the pain instantly changes, being then continuous, though still subject to exacerbations. There is little or no *abdominal tenderness*, unless peritonitis supervene, and the vital depression of acute obstruction is replaced by *gradual failure of the vital powers*, with *emaciation*. The *vomiting* in chronic obstruction is less severe than in the acute variety, and not so apt to be stercoraceous, except before a fatal termination when the occlusion has become complete. *Constipation* is probably the most important symptom in chronic obstruction, but it is by no means constant, and often alternates with, or is entirely replaced by, *diarrhœa*. I saw in consultation, some months since, a physician, whom I found to be suffering from cancer of the rectum, which ultimately proved fatal by perforation followed by fecal extravasation and peritonitis; he was totally unaware of his condition, and had for six months been treating himself for chronic diarrhœa. Even in cases of fecal impaction, there is often developed a catarrhal state of the bowel, causing a spurious diarrhœa which masks the patient's real condition. In chronic invagination, according to Rafinesque's statistics, diarrhœa is the rule and constipation the exception. *Tenesmus* is often well marked when the obstruction is in the lower bowel. The *flow of urine* is not commonly affected in chronic obstruction, unless the lesions be near the upper end of the small intestine, when, as already pointed out, it may be diminished. *Tympanites* is not an early symptom in chronic obstruction, but may become quite prominent toward the termination of the case. When the obstruction affects the rectum or sigmoid flexure, the colon may perhaps be traced along the border of the abdomen, distended with fecal matter, while the tympanitic small intestines occupy the intermediate space. Coils of distended intestine may often be recognized both by touch and sight, especially during paroxysms of pain, and may be seen rolling over each other, as it were, with loud borborygmus and gurgling, the peristaltic motion being obviously arrested at the seat of occlusion. The *tumor* of intussusception appears to have been less often observed in chronic than in acute cases, but, as justly remarked by Rafinesque, it would no doubt have been noted more frequently if it had been oftener looked for. The tumor of fecal impaction has already been referred to. A distinct tumor can sometimes be observed in cases of obstruction from malignant neoplasm.

DIAGNOSIS OF INTESTINAL OBSTRUCTION.

There can hardly be any difficulty in distinguishing between acute and chronic obstruction of the bowels, when it is remembered that in the former only are the symptoms those with which surgeons are familiar as accompanying strangulated hernia. But when chronic obstruction suddenly becomes acute, its diagnosis from that which is primarily acute is more difficult. Here the surgeon must be mainly guided by the history of the case, and perhaps by noting visible movements in the intestinal coils, a symptom, as already pointed out, almost entirely limited to cases of chronic obstruction.

The differential diagnosis of the various forms of obstruction, and, especially in chronic cases, of the part of the bowel involved, are matters of the highest importance, as bearing directly on the question of treatment.

Differential Diagnosis in Acute Obstruction.—The most important point to be determined here is whether the obstruction is due to *enteritis*, or whether there is positive *mechanical occlusion*. In the former case a cure may probably be effected by the judicious employment of general and local remedies; in the latter case the only hope of recovery will often lie in prompt operative interference.

In *enteritis* there will be pain, mainly of a colicky character, with marked tenderness over the affected portion of bowel. There will probably be dorsal decubitus, and, if general peritonitis be setting in, the limbs will be drawn up as in that affection. There may be vomiting, but it is not a very marked symptom, and the ejecta will seldom be stercoraceous. There will be constipation, but enemata will usually bring away small quantities of fecal matter, showing that there is not absolute occlusion. There may be an obscure fulness and hardness over the affected portion of intestine, but there will be no well-defined tumor, as in intussusception, and the results of rectal exploration will be negative. The patient will not be collapsed, as in internal strangulation, but, on the contrary, there will be some elevation of temperature, with other signs of fever. There will often be a history of exposure to cold, or of imprudence in diet, or of the administration of drastic purgatives.

If the case appear to be one of *mechanical occlusion*, the surgeon must endeavor to decide whether the obstruction be due to intussusception; to strangulation by a band, diverticulum, adhesions, or internal hernia; to acute volvulus; or to the lodgment of a gall-stone, enterolite, or foreign body.

Intussusception is by far the most frequent form of mechanical obstruction met with in children and young persons. It occurs suddenly, usually with severe and increasing pain, which afterwards somewhat diminishes. The pain is either paroxysmal, or, if continuous, presents distinct exacerbations. When the characteristic tumor is found, it is usually tender on pressure. Vomiting occurs, but is only exceptionally stercoraceous. Diarrhœa is rather more common than constipation; and in the large majority of cases there is a discharge of blood from the rectum. There is usually marked tenesmus, a symptom which Mr. Pollock considers pathognomonic. In about half of the cases a well-defined "sausage-shaped" tumor is observed, commonly on the left side of the abdomen, and it may often be felt by digital exploration of the rectum, or may even protrude through the anus. The patient is often collapsed, and the temperature is normal or subnormal unless general peritonitis occurs, and is even then not materially elevated.

Internal strangulation by bands, etc., is most common in young adults, and slightly more frequent in the male than in the female sex. It begins suddenly, with severe and continuous pain of a colicky character, often referred to the umbilicus. There is no tenderness, unless subsequent to the development of peritonitis. Vomiting is an early and most distressing symptom, and commonly becomes stercoraceous about the fifth day. There is complete constipation from the beginning. An enema may bring away the contents of the large intestine, but no fecal matter passes the seat of occlusion. Collapse is more marked in this than in any other form of intestinal obstruction. There is great thirst, depending probably on the excessive vomiting, and the flow of urine is often notably diminished. There is, in the majority of cases, a history of one or more previous attacks of peritonitis.

Volvulus is almost exclusively an affection of middle age and advanced life, and occurs in men about four times as often as in women. It occurs suddenly, with severe pain, at first intermittent but afterwards continuous, often referred to the umbilical region, and afterward to the sigmoid flexure, where the twisting usually occurs. There is commonly tenderness over the distended bowel. Vomiting is a comparatively unimportant symptom, and, when it occurs, often relieves the patient's suffering temporarily. There is complete constipation, and in some cases tenesmus, but no discharge of blood. Tympanites and meteorism occur early and increase rapidly, often causing dyspnœa by pressing on the diaphragm. The tympany is usually at first limited to the left side. There is less prostration than in internal strangulation. There is usually a history of previously existing constipation.

Obstruction by *gall-stones* is most common in elderly women. It begins suddenly, with severe pain, free vomiting, which ultimately becomes stercoraceous, and complete constipation. The patient is not prostrated as in other forms of acute obstruction. There have usually been previous attacks of a somewhat similar character. If a *foreign body* cause obstruction, a history of its having been swallowed can ordinarily be obtained. *Enterolites* often form such large masses that they can be detected by external palpation.

It is hardly necessary to say, that, in every case of acute intestinal obstruction, a careful examination should be made of all the localities in which external hernia may occur; in obstruction in new-born children, also, the anus and rectum should be examined to ascertain if there is any congenital malformation.

Differential Diagnosis in Chronic Obstruction.—In cases of chronic intestinal obstruction, it is important to distinguish between fecal accumulations, strictures of the bowel, and chronic invagination. The other forms of chronic obstruction are rare, and can usually be recognized by careful inquiry into the previous history and general condition of the patient; thus, in the case of *inflammatory changes* from traumatism, there will be a history of injury; in that of *tuberculous peritonitis*, there will be evidence of tubercle in other organs; while if the obstruction be due to the pressure of an *ovarian or uterine tumor*, the diagnosis may be made by noting the symptoms characteristic of those affections.

Fecal accumulations, as a cause of intestinal obstruction, are most common in adult women, and especially among the subjects of hysteria or insanity. In a case of this kind there is a history of long-continued constipation, gradually increasing in obstinacy, with swelling of the abdomen, distended coils of intestine being sometimes plainly visible on external inspection. As the swelling increases, the abdomen may become painful, and at a late period vomiting may occur, seldom, however, becoming stercoraceous. The most important symptom is the appearance of a doughy tumor, often pitting on pressure, and usually occupying the position of the cæcum. Intercurrent attacks of complete constipation are not infrequent, but readily yield to the use of enemata. Acute obstruction may follow as the result of paralysis of the gut (*ileus paralyticus*).

Stricture of the small intestine may be suspected if in a middle-aged person there have been frequent attacks of painful indigestion, with nausea or vomiting, occurring at fixed intervals after the ingestion of food, and with long intervals of entire freedom from suffering. The patient gradually becomes emaciated, and the intestinal movements can then often be traced through the abdominal wall. There is usually, but not invariably, constipation. If the stricture be of a malignant character, a tumor may be detected. Acute obstruction may occur as the result of sudden plugging of the constricted bowel with masses of undigested food, gall-stones, etc., or from the formation of a secondary volvulus, or from "kinking." In *stricture of the large intestine*, no connection can be traced between the occurrence of painful paroxysms and the ingestion of food; there is commonly tenesmus, and occasionally a discharge of blood from the rectum; and there is often marked tympanites. If the stricture involve the rectum or even the sigmoid flexure, it can usually be detected by digital or manual exploration.

Chronic invagination is most common in men, and in early adult life; it begins abruptly, and afterwards assumes a chronic character—this is a very significant circumstance—and presents many of the symptoms of acute invagination, only that they are less severe, and that the vital depression of that condition is wanting. The most distinctive symptoms, beside the mode of invasion, are the appearance of the characteristic tumor, and the discharge of blood from the rectum.

DIAGNOSIS AS REGARDS THE SEAT OF OBSTRUCTION.—In *acute* obstruction the part affected is usually the *small intestine*, and in *chronic* obstruction the *large bowel.* When *stercoraceous vomiting* occurs as an early symptom, the seat of obstruction is probably in the lower part of the small intestine; for, on the one hand, this symptom is not observed when the obstruction is in the upper part of the small bowel, and, on the other hand, in obstruction of the colon it occurs at a comparatively late period. The *amount of urine* secreted is probably not as important a diagnostic symptom as has been usually supposed, a diminished flow being rather significant of the acuteness than of the high seat of the obstruction; in chronic cases, however, anuria indicates obstruction comparatively near the pylorus. The *use of the long tube* for diagnostic purposes is deceptive, the sigmoid flexure being often so movable that the end of the tube, while still in that segment of intestine, may reach the umbilicus, and may then be supposed to be in the transverse colon. A certain amount of information may be gained by observing the *quantity of water that can be injected* into the lower bowel without escaping by the side of the injecting instrument; but even this test is not certain, for, on the one hand, the capacity of the rectum alone varies very much in different individuals, and, on the other hand, it would appear that an occluded bowel may be sometimes permeable by fluids injected from below, while resisting any passage of fecal matter from above. *Auscultation of the colon and cæcum*, while fluid is being injected into the rectum, is considered by Mr. Treves to be of great value; if the fluid can be distinctly heard to enter the cæcum, it gives evidence of course that the obstruction is not in the large intestine.

PROGNOSIS OF INTESTINAL OBSTRUCTION.

PROGNOSIS OF ACUTE OBSTRUCTION.—Acute obstruction of the bowel is always an affection replete with danger to the patient, and a cause of the gravest anxiety to the surgeon. By far the most favorable cases are those of *enteritis*, in which, indeed, under judicious treatment, a cure can usually be obtained. In acute *intussusception* there is at least a chance of spontaneous recovery, either by the bowel becoming disinvaginated under the influence of opium and enemata, or by sloughing and separation of the intussusceptum; the latter occurrence offers the most hope, as may be seen from Leichtenstern's statistics, which show that 557 terminated cases gave in all 151 recoveries (27 per cent.) and 406 deaths (73 per cent.), but that whereas 149 cases in which sloughing occurred gave 88 recoveries (59 per cent.) and only 61 deaths (41 per cent.), 408 cases in which sloughing did not occur gave but 63 recoveries (15 per cent.) and no less than 345 deaths (85 per cent.). But in the other forms of acute obstruction—*internal strangulation* (which, next to intussusception, is much the most common variety, constituting, according to Leichtenstern's figures, more than one-fourth of the whole), acute *volvulus*, etc.—the only hope of cure commonly lies in prompt operative interference, before the development of general peritonitis.

Prognosis of Chronic Obstruction.—The least dangerous form of chronic obstruction is that caused by *fecal accumulation*, which can ordinarily be removed without much difficulty. Even in cases of *intestinal stricture*, relief can often be afforded and the evil day warded off for a long while by the regulation of the diet and the judicious use of cathartics or enemata. The most unfavorable cases are those of *chronic invagination*, in which there is comparatively little chance of a cure by sloughing, and in which, therefore, if efforts at reduction by inflation, manipulation, etc., fail, operative measures become necessary.

Treatment of Intestinal Obstruction.

There is probably no class of cases so habitually mismanaged by otherwise intelligent practitioners, as that under consideration. This is partly owing to the fact that, these cases being comparatively rare, few physicians have the opportunity, or take the trouble, to make themselves familiar with their pathology, and hence, when forced to assume the responsibility of their treatment, administer remedies in the most empirical manner, and use their weapons, as it were, in the dark, and quite as often, therefore, to their patient's detriment as to their advantage. Thus, I have known frictions with ice to be persistently but, of course, fruitlessly employed in a case of intestinal stricture, and a patient with manifest intussusception to be tortured with repeated doses of calomel and jalap. Another reason for the unscientific way in which these cases are often treated, is that, since their prognosis is universally acknowledged to be very unfavorable, practitioners are tempted, on the "*anceps remedium melius nullo*" principle, to use heroic remedies which are certainly not harmless, and which are actually more likely to kill than to cure. In former times metallic mercury, and afterwards croton oil, were the battering-rams with which physicians tried to burst through the obstructions by which their patient's lives were threatened, and I very much fear that at the present day, the hasty resort to operative measures, encouraged by the much-vaunted modern triumphs of "abdominal surgery," is responsible for the loss of a good many lives which might perhaps be saved by more rational if less brilliant treatment.

I speak strongly upon this point, because I feel a certain degree of personal responsibility in the matter, an article published by myself some twelve years ago[1] having had a share in popularizing the operation of abdominal section in these cases. I would strongly urge that the surgeon should not, in any case of intestinal obstruction, open the abdomen, unless he has been able to form some distinct notion of what he expects to find, or at least until he has been able to satisfy himself that there is positive mechanical occlusion, and that no less dangerous operation will suffice for its relief.

Treatment of Acute Obstruction.—From my own experience, I am led to believe that a large proportion of the cases of acute intestinal obstruction met with in practice are really examples of *enteritis*, and that if they were recognized as such, and promptly treated, the number of recoveries would be much larger than it is at present. Remembering that, as Sir Thomas Watson

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[1] On laparotomy, or abdominal section, as a remedy for intussusception; with tables showing the results of the operation in cases of this affection, and in those of other forms of acute obstruction of the bowels. (American Journal of the Medical Sciences, July, 1874, pp. 48, 285.)

expresses it, enteritis "is in most cases peritonitis, and something more," I have no hesitation in saying that the remedy of prime importance is direct depletion by blood-letting. I have not employed general bleeding in these cases, but should not hesitate to do so if leeches could not be procured. I have, however, seen the whole aspect of the case changed by the application of leeches immediately over the inflamed segment of bowel. If the patient be a vigorous adult, at least twelve ounces of blood should be taken in this way, and the leeching should be repeated if the symptoms recur. After the leeching, the whole abdomen should be covered with mercurial ointment, and a warm mush or hop poultice then applied over all. At the same time, the patient should be brought under the influence of opium, and occasional enemata of warm water, warm flaxseed tea, or warm olive oil may be employed. No purgative should be administered by the mouth. If any marked tenderness persist the next day, a moderate-sized blister may be applied with advantage. The patient should take only small quantities of concentrated food, and if there be vomiting, it is better to rely upon nutritive injections. I cannot illustrate this subject better than by quoting Sir Thomas Watson's graphic account of his own case:—

> "I well remember," he says, "though it is now many years ago, being myself badly treated for enteritis. Being ill, in a strange place, I sent for the nearest practitioner, who happened to be a very ignorant man. Finding that I was sick, and that my bowels did not act, he gave me, for two or three days in succession, strong drastic purges, with no other effect than that of increasing my sickness and adding to the abdominal pain I suffered. I was then seen by a most intelligent physician (this was before I had paid any attention to physic myself), and the first thing he did was to have me copiously bled; and the immediate effect of that bleeding was to send me to the night-chair."

The course of treatment briefly sketched above is that which I would recommend in any case of obstruction recognized as depending upon enteritis; and I will go further, and say that in any case of acute obstruction *not obviously due to a mechanical cause*, this mode of treatment should be given a fair trial before resorting to an operation.

The special measures required by the different forms of acute obstruction, other than enteritis, will be considered presently, but I may refer first to certain indications for treatment which are common to all varieties. In the first place, bearing in mind that the most desperate cases sometimes end in spontaneous recovery, the surgeon should aim to *obviate the tendency to death* by relieving pain, lessening excessive peristaltic action, avoiding abdominal distension, and maintaining the patient's strength. The most important single remedy in cases of acute intestinal obstruction is *opium*, which may be given either by the mouth, or hypodermically in the form of morphia. If by the mouth, the watery extract of opium is the best preparation, and may be given in half-grain or grain doses, every three or four hours, in combination with small doses of the extract of belladonna. The only objection to the use of opium is that by relieving the symptoms it may obscure the diagnosis, but when once the nature of the case has been determined, opium may be given with great freedom. It relieves the pain, checks the vomiting, arrests the violent peristaltic action, and under its use the tongue becomes moist, and the flow of urine is increased. The *feeding* of the patient is a very important matter in all cases of intestinal obstruction. Only such food, if any, should be given by the mouth, as will furnish the maximum of nutriment with the minimum of fecal residue; indeed, in many cases it is better to abandon all efforts at feeding by the mouth, and to rely exclusively upon nutrient enemata. To relieve the thirst, which is so often a distressing symptom in intestinal obstruction, the patient may be allowed to suck pieces of ice, and large enemata of water may be frequently administered. Kussmaul, Cahn, Senator, and Hasenclever, in Germany; Chantemesse, Kuhn, and Fauche, in France; and Whittaker, of Cincinnati, in America, recommend washing out the stomach, as a means of evacuating the fluid contents of the upper part of the small intestine, and thus relieving the distension and allaying the vomiting.

The use of *purgatives*, whether by the mouth or by the rectum, should be absolutely forbidden; but simple *enemata of warm water*, or, which Head prefers, of *warm oil*, administered through a long tube or nozzle, and preferably by the siphon or "gravity" method, are often of very great value, and may even be efficient in pushing back the invaginated bowel in the early stages of an intussusception. Libur and Jate have recorded cases in which cures were effected by the injection successively of solutions of *bicarbonate of sodium* and of *tartaric acid*, and Ziemssen considers injections of this kind much more valuable than those of simple water; enemata of *ox-gall* have been recommended by Murray, of Newcastle-on-Tyne; and *iced-water injections* (which form an important part of what is known as Grissolle's method of treatment) have been successfully employed by Kormann, of Coburg. *Tobacco enemata* were formerly held in high repute, and were favored by the late Dr. Brinton. They are, however, dangerous in themselves, and their advantage over safer remedies is at least doubtful. *Inflation of the intestine with air*, introduced through a long tube or with a long-nozzled bellows—a mode of treatment as old as Hippocrates—has occasionally succeeded in relieving the obstruction after the failure of other methods, and is certainly worthy of trial in a doubtful case, before resorting to an operation. An ingenious instrument for inflating the bowel has been devised by Mr. Lund, of Manchester, its most important feature being the adaptation of a hollow elastic ring, which, being firmly pressed against the anus, prevents the escape of air by the side of the injecting tube.

A few other remedies must be briefly mentioned. The administration of *metallic mercury* was in past times often resorted to in the treatment of intestinal obstruction, and this plan has of late years found an able advocate in a French writer, M. Matignon. There can be no doubt that in cases of obstruction from fecal impaction, the use of mercury in this way has often been successful—not, as was formerly supposed, by the weight of the metal carrying everything before it, but, as pointed out by M. Matignon and Mr. Treves, by the drug becoming very finely divided in its onward passage, and by the resulting particles mechanically insinuating themselves around and amid the fecal mass, and thus causing its dislodgment and disintegration. In cases of intussusception or internal strangulation, however, mercury could certainly do no good, and would only aggravate the patient's condition. Small doses of *calomel*, intended to produce the antiplastic and alterative effect of the drug, are often administered in connection with opium, but are objectionable in cases of absolute mechanical obstruction, as tending to increase the distension of the bowel by their cathartic action: upon the whole, I think it safer, when a mercurial is indicated, to employ inunction in the way already described when speaking of the treatment of enteritis. The use of *ice* by enema has already been referred to, but in what is called Grissolle's method, it is also employed externally; Habershon refers to cases in which such an application was successful, and in cases of *ileus paralyticus*, from distension, it might do good by stimulating peristaltic action. But where peristalsis is already excessive, as is ordinarily the case in acute obstruction, its effect would be rather prejudicial than otherwise. *Electricity* no doubt acts in the same way as ice—by promoting peristaltic action—and may be of service in the same class of cases; it has been successfully employed by Finny, Giommi, and others, and Boudet claims no less than 44 recoveries out of 61 cases thus treated. *External manipulation*, or *massage*—gently rubbing and kneading the abdomen (*abdominal taxis*)—has been occasionally employed with advantage both in cases of intussusception and in those of obstruction by gall-stones. It should be used with great moderation, and preferably while the patient is in a state of anæsthesia. It may be aided, as may the administration of enemata, by elevating the patient's hips, by placing him in the knee-elbow position, or, in the case of an infant, by complete inversion.

The *operative measures* employed for the relief of intestinal obstruction may be classified as (1) *paracentesis*, or puncture of the bowel; (2) *laparotomy*, or abdominal section, essentially an exploratory operation; (3) *enterotomy* and *colotomy*, or incisions into the small and large intestines respectively; and (4) *enterectomy* and *colectomy*, or resections of the same organs. Before describing these operations, however, it will be desirable to consider briefly the special treatment of particular forms of acute mechanical obstruction, as well as the treatment of chronic obstruction.

Treatment of Obstruction by Foreign Bodies, Gall-stones, Enterolites, etc.—The patient should be brought under the influence of opium, and large enemata of warm water or oil may be administered, in hope that by distending the bowel *below* the obstructing body, the advance of the latter may be facilitated. If the position of the foreign body can be determined, attempts may be made to push it onwards by external manipulation. These means failing, laparotomy must be preferred, the gut opened (*laparo-enterotomy*, *laparo-colotomy*), and the obstructing body extracted. If the bowel be healthy, it may be sewed up and returned, but otherwise an artificial anus must be established, at least temporarily.

Treatment of Acute Intussusception.—Opium should be freely administered, and persistent attempts should be made to push back the invaginated gut by the use of enemata, inflation of the bowel, and the cautious employment of abdominal taxis. Laparotomy has of late years been frequently performed in cases of this kind, but I confess it seems to me with doubtful advantage. In *acute* intussusception, even if disinvagination cannot be effected, there is a fair prospect of recovery by separation and discharge *per anum* of the intussusceptum. The mortality of all cases taken together is nearly 73 per cent.,[1] and the mortality after laparotomy[2] over 75 per cent., so that, as far as figures bear upon the question, the operation would seem to have done more harm than good. I may add that Mr. Bryant, whose opinion on any point of practical surgery is entitled to the highest respect, advises that enterotomy should be preferred in any case in which it does not appear likely that laparotomy would succeed, as affording relief from the most urgent symptoms, and allowing time for the separation of the invaginated part. In *chronic* intussusception the mortality is considerably larger (over 86 per cent., according to Rafinesque), and as here there is little or no prospect of a cure by sloughing, laparotomy may be properly resorted to in any case which does not yield to other treatment. If the operation is performed, and it be found impossible to disinvaginate the bowel, the part should be resected, and an artificial anus temporarily established.

Treatment of Volvulus.—Opium should be given here, not as a curative, but as a palliative remedy. Injections can be of service only in the early stages of volvulus, and when there is much distension are probably useless. These are the cases in which paracentesis is sometimes efficient, by evacuating gas or liquid fecal matter, and permitting the twisted bowel to right itself. The operation should be done with a very small trocar and canula, or an aspirating tube, and the puncture should be made in the distended gut above the volvulus. If paracentesis fail, the bowel should be opened by an incision, and, as the disease usually affects the sigmoid flexure, left lumbar colotomy is the operation to be performed.

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[1] See Leichtenstern's statistics quoted on page 59, *supra*.

[2] See Table I., p 70, *infra*.

Treatment of Strangulation by a Band or Diverticulum, Internal Hernia, etc.—Here, too, opium is useful only as a palliative remedy. No time should be lost before resorting to laparotomy, and after the strangulation has been relieved by dividing between two ligatures, or excising, the constricting bands, etc., the bowel should be dealt with as in ordinary strangulated hernia—returned, if healthy; slit up or resected, and secured to the abdominal wall, if in a state of gangrene.

Treatment of Chronic Obstruction.—In chronic obstruction of the bowels a great deal can be done to promote the patient's well-being by regulating the *diet*—avoiding indigestible substances, and employing such food only as will not be likely to form a hard mass in the intestine. By restricting the diet to liquids, patients with stricture of the bowel have sometimes been enabled to live many years in comparative comfort, and even in cases of chronic invagination life has occasionally been prolonged for several months by attention to dietetic measures. *Laxatives* and mild *aperients* are often of use in chronic obstruction, and opening enemata are frequently of great service. It is in these cases, too, that benefit is likely to be derived from the application of *electricity.*

Treatment of Fecal Accumulations.—The most important part of the treatment of these cases is the persistent use of enemata, which, if thought proper, may be carbonated by the successive injection of bicarbonate-of-sodium and tartaric-acid solutions, in the way already described. Friction with ice, electricity, and massage, may all be of use, as means of increasing or supplementing peristaltic action. The administration of metallic mercury may be tried if other measures fail. Paracentesis may be required to relieve extreme gaseous distension. Colotomy, and even laparotomy, have been employed in these cases, but, it is charitable to suppose, usually through a mistake in diagnosis. The performance of these operations in cases of fecal accumulation must be looked upon, as Mr. Treves justly observes, "rather as a surgical misfortune than as a recognized means of treatment."

Treatment of Intestinal Stricture.—In stricture of the small intestine, when dietetic measures, laxatives, etc., fail to give relief, operative interference is necessary. Laparotomy, followed by resection of the constricted portion of gut, is the most radical method of treatment, but when this is inadmissible, simple enterotomy may be substituted as a means of at least prolonging life. The objection to enterotomy in cases of stricture of the smaller bowel is that, from the position of the artificial anus thus formed, intestinal digestion is interfered with, and nutrition consequently suffers. When an operation is required for stricture of the large intestine, *right* lumbar colotomy, or, in some cases, colectomy, is the method to be adopted.

Treatment of Chronic Invagination.—Persistent efforts should be made to effect reduction by the use of enemata, inflation of the bowel, abdominal taxis, etc., but if these fail laparotomy must be resorted to. If possible, the bowel should be disinvaginated; but if this cannot be done, the affected portion should be resected. Mr. Howse suggests that when the bowel protrudes through the anus, it should be held down with pins and then excised. He refers to a case in which this was done unwittingly by an Italian surgeon, the patient recovering, and Mr. Treves refers to several similar cases; the same plan has been successfully followed by Prof. Mikulicz (in two cases), by Dr. Willard, of Philadelphia, and by Dr. Fuller, of Michigan. A case in the hands of Auffret, of Brest, however, ended fatally a few hours after the operation.

Operative Treatment of Intestinal Obstruction.

Paracentesis or Puncture of the Bowel.—The simplest operation which is performed in cases of intestinal obstruction is that of puncturing one or more distended coils with a fine trocar and canula, or with the hollow needle of an aspirator. This procedure, which has been especially recommended by Gross, Demarquay, Wagstaffe, and Dozzi, often affords great relief by allowing the escape of gas, and even of liquid feces, from the distended bowel. I have myself employed it with advantage as a palliative measure, and it has occasionally proved curative, probably in cases of extreme flexion, or what Mr. Treves calls "kinking," of the bowels, and possibly in some cases of volvulus, or even of internal hernia. The operation is not, however, entirely free from risk, as fecal extravasation has occasionally followed, and death, directly traceable to the puncture, ensued in three out of ten cases recorded by Fräntzel, of Berlin. A slender instrument should be employed, and if distended coils of intestine can be recognized through the abdominal wall, the puncture may be made in one of these. Several punctures may, if necessary, be made in succession, at different points, and the operation may be repeated as often as necessary. In a remarkable case recorded by Dr. Blake, and cited by Mr. Treves, no less than 150 punctures were made in the course of eighteen weeks.

Paracentesis may occasionally be useful in facilitating diagnosis by relieving tympany, and thus permitting more accurate examination of the abdomen. It has also been recommended as a preliminary to laparotomy, in which operation the escape from the abdomen of distended coils of intestine forms a serious complication.

Under the name of *enterocentesis*, a French writer, Dr. Larguier des Bancels, recommends puncturing the bowel with a large trocar and canula, the latter being retained in position for several days. This operation is justly condemned by Mr. Treves, who characterizes it as "an enterotomy performed in the dark," and I cannot see that it presents any advantages over that procedure, while it is in many respects its inferior.

Laparotomy.—This term (for the introduction of which into English and American surgical literature I believe that I am myself chiefly responsible)[1] has long been used by German writers to denote the operation of simple abdominal section for whatever purpose performed. *Laparotomy* (λαπάρα, the soft part of the body below the ribs, and τέμνω, I cut) is in itself essentially an exploratory operation, which may or may not be followed by incision or excision of any of the abdominal viscera. It is a better term than *gastrotomy*, which is also applicable to, and should I think be reserved for, the operation of opening the stomach.

Laparotomy appears to have been first suggested as a remedy for intussusception by Praxagoras, of Cos, one of the Asclepiadæ, who flourished about three and a half centuries before the Christian era. This statement is made on the authority of a passage in the work of Cælius Aurelianus on Acute Diseases[2] (for no writings of Praxagoras himself have come down to posterity), though Hévin,[1] who wrote against the operation in the last century,[2] declares that the passage has been misinterpreted, and that Praxagoras merely taught the proper use of the knife in cases of strangulated hernia. The passage is no doubt an obscure one, but Hévin seems to me to have still further darkened counsel by his interpretation of it. Praxagoras, Cælius Aurelianus says, employed emetics until he caused the vomiting of feces; some, after vomiting, he bled, and filled with wind through the anus, as advised by Hippocrates; and again, following Hippocrates, ordered the giving of sweet wine, etc. He then adds: "Some, in whom the intestine which the Greeks called the *blind gut* had, being filled with much fecal matter, slipped into the scrotum, he, pressing the bowels with his hands, vexed with great shaking. In some, again, the above-named remedies having been exhausted, he advised that the belly should be divided even to the pubes (*dividendum ventrem probat pubetenus*); he said also, coming to impudent (*protervam*) surgery, that the rectum[3] should be divided, and sewed up again when the feces had been withdrawn." The first sentence quoted, no doubt indicates a rough kind of taxis in cases of scrotal hernia, but the second seems to me, by every fair interpretation of the text, to refer not merely to cases of hernia, but to cases of the "iliac passion" generally. Certainly the ordinary operation for scrotal hernia does not consist in dividing the belly even to the pubes.

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[1] See the Article already referred to in the Amer. Journal of the Med. Sciences, July, 1874.

[2] De Morbis Acutis et Chronicis, lib. iii. cap. xvii. pag. 244. Amstelod. 1722.

There is no evidence, however, that Praxagoras ever himself performed the operation, and the next reference to it appears to date back no further than the latter part of the seventeenth century, when Paul Barbette, a surgeon of Amsterdam, after describing the symptoms, and pointing out the often hopeless character, of intussusception, asks[4] "whether it would not be better, having made a dissection of the muscles and peritoneum, to take the intestine with the fingers and draw it out, than to abandon the patient to certain death?" Commenting upon this passage, Bonetus[5] gives the details of what must be considered the first recorded case of laparotomy for intussusception. The patient was a "Baroness L—," the operator was a young army surgeon, and the operation was entirely successful. A second successful case occurred in the practice of the celebrated Nuck (who, however, did not operate himself, but called in for the purpose an unnamed but "most skilful surgeon"), and is narrated in the Inaugural Thesis of Dr. Velse.[6] The intussusception in this case appears to have been of the chronic variety, and at the operation the bowels were found "neither yet inflamed, nor adherent (*inflammata necdum, nec coalita*)." The patient survived the operation twenty years.

Other laparotomies for intussusception were recorded by Ohle (1810), Fuchsius (1825), Gerson (1828), Wilson (1835), Hauff (1842,) Pirogoff (1852), Spencer Wells (1863), Laroyenne (1870), Weinlechner (1872), Athol Johnson (1873), Jonathan Hutchinson (1873), and John Duncan (1874). Of these fourteen cases, which I analyzed in 1874,[7] five ended in recovery and nine in death; a mortality up to that date of less than 64 per cent., or, if the cases recorded in this century only be considered, of exactly 75 per cent., a death-rate which, large as it is, has unfortunately not grown less as the operation has been more frequently performed.

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[1] Mém. de l'Acad. de Chirurgie, tome iv. p. 264. Paris, 1819.

[2] In a posthumous memoir, however, published in 1836, Hévin took a diametrically opposite view of this question, and strongly advocated the operation in certain cases. See Ducros, Archives Gén. de Médecine, Août, 1838, p. 461.

[3] M. Hévin's suggestion that perhaps the expression *rectum intestinum*, in this passage, does not mean the rectum, seems hardly worthy of contradiction.

[4] Anatom. Pract., lib. iv. cap. i.

[5] Sepulchretum, tom. ii. pag. 228. Genevæ, 1700.

[6] Hallerus, Disputat. Anatom. Select., tom. vii. pag. 126. Gottingæ, 1751.

[7] Loc. cit.

The circumstances which indicate or contraindicate a resort to laparotomy in cases of intestinal obstruction have already been referred to, and it remains merely to describe the operation itself, and to consider its statistical results.

Laparotomy is thus performed: The patient is thoroughly etherized, placed in the recumbent posture, and brought with his buttocks to the foot of the operating table or side of the bed, so that the surgeon can stand between the lower limbs, which should be supported on chairs or stools at a convenient heigh' The temperature of the room should be at least 70° F.—better 75° or even 80°—and the patient's bladder should be evacuated with a catheter immediately before beginning the operation. If the symptoms of obstruction have followed the reduction of a hernia *en masse*, or a herniotomy in which the sac was not opened, this may first be explored, and the incision then, if necessary, extended into the abdominal cavity; or if the case be one of impacted gall-stone, foreign body, or enterolite, and if the seat of obstruction can be positively determined by palpation of the abdominal parietes, the incision may be made directly over the occluding substance.[1] But in most cases a longitudinal incision in the median line of the belly will be preferable, the wound extending from an inch below the umbilicus downwards for about four inches. The advantages of a median incision are that it affords the greatest facility for exploring all parts of the abdomen, and that the wound unites more readily than one which entails division of muscular tissue.[2] The skin and fascia having been cut through, the dissection is cautiously carried down to the peritoneum, in which membrane a small opening is then made, and enlarged as much as may be necessary with a probe-pointed bistoury introduced upon the finger as a director. Search is next to be made for the seat of obstruction. In doing this it is generally directed that the distended bowel should be traced downwards, but Mr. Hulke's suggestion seems to be a better one, that the contracted and empty bowel should be sought first, and then traced upwards. It is very important that the bowels should not be allowed to escape from the abdominal cavity, and to prevent this the sides of the wound should be supported by assistants, who should gently steady them, but not compress them, with towels or sponges. If the distension be so great as to impede the surgeon's manipulations, one or more coils may be punctured with a fine trocar and canula, introduced through the wound, or, guided by the surgeon's hand in the wound, through the abdominal parietes.

Mr. Treves advises, and I think judiciously, that the operator should first pass his hand to the position of the cæcum, by noting the condition of which he can usually at once decide whether the obstruction is in the large or small intestine. If the cæcum is distended, the large bowel is the seat of occlusion, and the surgeon then follows with his hand the course of the colon until he comes to the part affected; if, on the other hand, the cæcum is empty, the obstruction must be in the lesser bowel, and search is then made for undistended coils of small intestine, first in the cæcal region and about the upper edge of the pelvis, and then in the pelvic cavity where the empty loops are apt to hang when the obstruction is high up. In order to determine the direction in which the surgeon should proceed in seeking for the junction of the collapsed and distended portions of intestine, Mr. Rand recalls the anatomical fact that the root of the mesentery is attached to the spinal column, extending from the *left* side of the second lumbar vertebra obliquely downwards to the *right* sacro-iliac symphysis, and maintains that by examining the mesenteric attachment of any loop of bowel that may be found, it can be determined which is its upper end, and in which direction therefore the search should be pursued. It must be obvious, however, that the relations of parts may be so changed by the presence of adhesions, or by alterations in the mesentery itself, that this ingenious suggestion cannot be always available.

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[1] Of course, the rectum should have been carefully and repeatedly examined to make sure that it is not itself the seat of obstruction, in which case laparotomy would be contraindicated, and colotomy would be the operation to be chosen.

[2] Dr. Fitz recommends, in cases of obstruction due to other causes than intussusception, that the incision should be made in the lower right quadrant of the abdomen, since bands are most frequent in this locality.

The seat of obstruction having been found, the course to be pursued depends upon its nature. Strangulating *bands* or *adhesions* must be divided, if necessary between two ligatures; if the bowel be caught in a *slit in the omentum*, or *mesentery*, or if there be an *internal hernia*, the constricted gut must be released. If the case be found to be one of *volvulus*, an attempt should be made to untwist and replace the bowel, and if this cannot be done, the distended segment should be opened and an artificial anus established, or the part if gangrenous should be cut away, in the manner which will be described when I come to speak of enterectomy. If the obstruction be due to the impaction of a *foreign body*, *gall-stone*, or *enterolite*, enterotomy should be performed, and the offending substance removed, the case being then treated as one of wounded intestine. *Stricture of the bowel* requires the establishment of an artificial anus, or, if the stricture be malignant, perhaps enterectomy; and the same course should be pursued if the case should prove to be one of *intussusception*, if the invagination were irreducible or the gut already gangrenous. In attempting to reduce an intussusception, more can usually be accomplished by gentle squeezing and pushing from below, than by pulling from above; it may be sometimes necessary to open the bowel below the invagination so as to introduce a finger to act directly upon the intussusceptum.

In all these manipulations, great care must be taken to avoid injuring the distended bowel, which may readily be ruptured by even slight violence, and, as already mentioned, it is important that no protrusion should be permitted: indeed Ruata advises that, in any case, if the cause of obstruction cannot be discovered without allowing the bowels to escape from the abdominal cavity, an artificial anus should be at once established.

If the bowel is not to be opened, the external wound should be immediately closed, after carefully removing, by sponging, all effused fluids from the peritoneum. Any ligatures that are required should be cut short, so as to allow of their becoming encysted, and the edges of the wound should be accurately adjusted with numerous silk sutures, as after the operation of ovariotomy. If peritonitis be present at the time of the operation, it will be prudent to fix a drainage-tube at the lower end of the incision.

With regard to the use of what are called "antiseptic precautions" in this operation, I think the spray objectionable, as likely to chill the exposed abdominal viscera; but I can see no harm in the surgeon adopting the other measures recommended by Sir Joseph Lister, if he thinks that by doing so he renders the operation safer for his patient. It is to be observed, however, that Sir Joseph Lister has himself declared that "antiseptic measures" are less important in abdominal operations than in any others—the peritoneum being inapt for absorption of septic matters—and that two at least of the most successful operators on the abdomen (Dr. Keith and Mr. Lawson Tait), have abandoned "Listerism" as positively injurious. It may be added, too, that the mortality of laparotomy for intestinal obstruction is shown by statistics to have upon the whole somewhat increased since the prevalence of "antiseptic surgery."

The *statistics* of laparotomy for obstruction of the bowels have been studied by numerous writers, including Adelmann and Schramm in Germany; Delaporte, Bulteau, and Peyrot, in France; Treves, in England; and Whitall, Sands, and myself, in America. In an article already alluded to, published in 1874, I collected 74 cases of this operation, and in the successive editions of my "Principles and Practice of Surgery," I have largely added to these figures, so that my list now embraces 346 cases, a greater number than has heretofore been brought together. In the accompanying tables, I have given references to all the cases of which I have sufficient knowledge, classifying them according to the nature of the affection for which the operation was performed. A considerable number of cases, chiefly fatal, may be found noted in the statistical reports of various hospitals, but without particulars, and without the names of the operators.

An analysis of these tables shows that the mortality of the operation in terminated cases of all kinds has been over 69 per cent.; that the least unfavorable cases are those of obstruction by foreign bodies, gall-stones, etc., and by pressure from sources external to the bowel; and that the gravest cases are those of intussusception, followed closely in the rate of mortality by those of internal strangulation and volvulus. The figures bearing upon these points may be compendiously seen in the annexed summary:—

ANALYSIS OF 346 CASES OF LAPAROTOMY FOR INTESTINAL OBSTRUCTION EMBRACED IN TABLES I.—IX.

Nature of obstruction.	Cases.	Result not ascertained.	Recovered.	Died.	Mortality per cent. of terminated cases.
Intussusception	65	...	16	49	75.4
Volvulus, etc.	29	1	8	20	71.4
Strangulation persisting after herniotomy or taxis	21	...	6	15	71.4
Foreign bodies, impacted feces, gall-stones, etc. .	23	1	9	13	59.1
Tumors, strictures, ulcers, etc.	37	2	10	25	71.4
Strangulation by bands, adhesions, diverticula, etc.	119	1	38	80	67.8
Various forms of hernia, and "ileus" . . .	26	1	8	17	68.0
Other forms of obstruction	7	...	3	4	57.1
Not ascertained	19	1	6	12	66.7
Aggregates	346	7	104	235	69.3

Comparing these with the less extended statistics which I was able to publish in 1874,[1] when I could find but 74 recorded cases of laparotomy for intestinal obstruction, giving 50 deaths (67.6 per cent.), it is seen that, contrary to what is usually observed in the history of operations, the gravity of this one increases rather than diminishes, as it is more often resorted to.

For convenience of comparison, I have appended an analysis of the 190 cases collected by Dr. Schramm:—

ANALYSIS OF 190 CASES OF LAPAROTOMY FOR INTESTINAL OBSTRUCTION EMBRACED IN DR. SCHRAMM'S TABLES.[2]

Nature of obstruction.	Cases.	Recoveries.	Deaths.	Mortality per cent.
Intussusception	27	8	19	70.4
Volvulus, etc.	22	5	17	77.3
Strangulation persisting after herniotomy, etc. . .	11	6	5	45.5
Foreign bodies, etc.	7	4	3	42.9
Tumors, etc.	38	16	22	57.9
Internal strangulation, bands, adhesions, and diverticula	77	24	53	68.8
Unascertained	8	5	3	37.5
Aggregates	190	68	122	64.2

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[1] Loc. cit., page 285.

[2] Archiv f. klin. Chirurgie, Bd. xxx. H. 4.

TABLE I.—CASES OF LAPAROTOMY FOR INTUSSUSCEPTION OF THE BOWELS.

No.	Operator or Reporter.	Result.	Reference.
1	Agnew,	Died.	Principles and Practice of Surgery, vol. i. p. 402.
2	Ancrum,	“	Charleston Med. Journal, Oct. 1874.
3	Anger,	“	Clos, Thèse de Paris, 1883.
4	Beck,	“	Brit. Med. Journ., Dec. 16, 1882.
5	Bell, H. R.	“	Lancet, Jan. 1, 1876.
6	Bell, Jos.	“	Brit. Med. Journ., May 29, 1875.
7	Id.[1]	“	Edinb. Med. Journ., July, 1882.
8	Bonetus,	Recovered.	Sepulchretum, tom. ii. p. 228.
9	Borch,	“	Norsk Mag. f. Lægevid., Bd. xv., and Med. Chronicle, July, 1885.
10	Briggs,	“	Trans. Med. Soc. Tennessee, 1879.
11	Brown,	Died.	Brit. Med. Journ., Dec. 16, 1882.
12	Carrier,	“	Hutchinson, Med.-Chir. Trans., vol. lvii. p. 39.
13	Davies-Colley,	“	Bryant, Brit. Med. Journ., Nov. 22, 1884.
14	Duncan,	“	Edinb. Med. Journ., June, 1874.
15	Estill,	Recovered.	Virginia Med. Monthly, vol. viii.
16	Fagge,	Died.	Lancet, Dec. 19, 1874.
17	Id.	Recovered.	Ibid.
18	Id. and Howse,	“	Ibid., Dec. 18, 1875, and Med.-Chir. Trans., vol. lix.
19	Franks,	Died.	Dublin Journ. of Med. Sci., June, 1884, and Jan. 1885.
20	Fuchsius,	Recovered.	Jour. d. pract. Heilkunde, Bd. lx. St. ii. S. 42.
21	Gerson,	Died.	Zeitschr. f. d. ges. Med., Bd. xiv. S. 303.
22	Godlee,	Recovered.	Brit. Med. Journ., Dec. 16, 1882.
23	Id.	Died.	Ibid.
24	Id.	“	Ibid.
25	Hauff,	“	Schmidt's Jahrbucher, Bd. xl. S. 214.
26	Haward,	“	Brit. Med. Journ., Dec. 16, 1882.
27	Hill,	Recovered.	Medical Record, June 17, 1882.
28	Howse,[2]	Died.	Med.-Chir. Trans., vol. lix.
29	Id.[2]	“	Brit. Med. Journ., Dec. 16, 1882.
30	Id.[2]	“	Ibid.
31	Id.	“	Ibid.
32	Id.	“	Ibid.
33	Hubbell,	“	Buffalo Med. and Surg. Journal, Feb. 1880.
34	Hulke,	“	Lancet, June 7, 1879.
35	Hutchinson,	Recovered.	Brit. Med. Journ., Dec. 6, 1873.
36	Id.	Died.	Lancet, Dec. 18, 1875.
37	Hutchison,	“	Medical Record, April 22, 1882.
38	Jacobi,	“	Kudlich, Ibid., March 18, 1882.
39	Johnson,	“	Holmes, Brit. Med. Journ., Dec. 6, 1873.
40	Laroyenne,	“	Servier, Thèse, 1870.
41	Little,	“	Medical Record, July 6, 1878.
42	Lloyd,	“	Brit. Med. Journ., May 23, 1885.
43	Marsh,	Recovered.	Med.-Chir. Trans., vol. lix.
44	Id.	Died.	St. Barth. Hosp. Reports, vol. xii. p. 95.
45	Mason,	“	Medical Record, April 22, 1882.
46	Mikulicz,	“	Archiv f. klin. Chirurgie, Bd. xxx.
47	Morris,	“	Brit. Med. Journ., Jan. 20, 1877.
48	[Nuck],	Recovered.	Haller, Disp. Anat. Select., tom. vii. p. 126.
49	Nussbaum,	“	Phila. Med. Times, Sept. 1, 1877.
50	Obalinsky,	Died.	Revue des Sciences Médicales, 15 Juillet, 1885.
51	Ohle,	“	Mag. f. d. ges. Heilk., Bd. ii. S. 253.
52	Page,	“	Med.-Chir. Trans., vol. lxi.
53	Pirogoff,	“	Vermischte Abhandl. u. s. w., 1852, S. 150.
54	Pollard,[2]	“	Lancet, March 17, 1883.
55	Pyle,	Recovered.	Nashville Med. Journ., vol. xxv. p. 64, 1880.
56	Sands,	“	New York Med. Journ., June, 1877.
57	Id.	Died.	Medical Record, April 22, 1882.
58	Stage,	“	Schmidt's Jahrbucher, Bd. clxxxviii. H. 3, 1880.
59	Tiffany,	“	Maryland Med. Journal, Dec. 1, 1883.
60	Tuffier,		Bull. de la Soc. Anat. de Paris, 1881.
61	Waldenströn,		Schmidt's Jahrbucher, Bd. clxxxviii. H. 3, 1880.
62	Weinlechner,		Ibid., Bd. clvi. S. 119.
63	Wells,	“	Trans. Path. Soc. Lond., vol. xiv. p. 170.
64	Wilson,	Recovered.	Am. Journ. Med. Sci., O. S., vol. xviii. p. 262.
65	[Case at St. Mary's Hospital, Lond.]	Died.	Brit. Med. Journ., Dec. 16, 1882.

[1] In case 7 there were also volvulus and strangulation by a band.

[2] In cases 28, 29, 30, and 54, portions of intestine were exsected.

TABLE II.—CASES OF LAPAROTOMY FOR VOLVULUS.

No.	Operator or Reporter.	Result.	Reference.
1	Atherton,	Died.	Bost. Med. and Surg. Journ., June 7, 1883.
2	Banks,[1]	“	Clinical Notes on Two Years' Surgical Work, etc., p. 101.
3	Bardeleben,	Recovered.	Medical News, June 27, 1885.
4	Berndt,	“	Adelmann, Prag. Vierteljahrschr., Bd. lxxviii. S. 42.
5	Bouilly,	Died.	Gazette Médicale, 19 Mai, 1883.
6	Buchanan,	Recovered.	Lancet, vol. i. p. 776, 1871.
7	Bull,	Died.	Schmidt's Jahrbucher, Bd. clxxxviii. H. 3.
8	Cantelmassa,	Undeterm'd	Revue des Sciences Médicales, Oct. 1875.
9	Erichsen,	Died.	Lancet, vol. i. p. 108, 1850.
10	Fergusson,	“	Syst. of Pract. Surgery, p. 651, 1870.
11	Firth,	“	Brit. Med. Journ., July 29, 1882.
12	Fowler,	“	Ibid., Jan. 20, 1883.
13	Gross,	“	Syst. of Surgery, vol. ii., and private letter.
14	Id.	“	Ibid.
15	Halley,	“	Medical Record, June 17, 1882.
16	Hoegg,	“	Sandifort, Thesaur. Dissertat., t. iii. p. 87.
17	Lindstet und Waldenströn,	Recovered.	Schmidt's Jahrbucher, Bd. clxxxviii. H. 3.
18	Medini,	“	Lancet, June 21, 1884.
19	Mikulicz,	Died.	Archiv f. klin. Chirurgie, Bd. xxx.
20	Id.[2]	Recovered.	Centralbl. f. Chirurgie, No. 45, 1884.
21	Obalinski,	“	Wien. med. Presse, 1884.
22	Id.	Died.	Revue des Sciences Médicales, 15 Juillet, 1885.
23	Polaillon,	“	La France Médicale, t. i. 1883.
24	Reali,	Recovered.	Froriep's Notizen, 3 R., Bd. ix. S. 95.
25	Ritter,	Died.	Adelmann, loc. cit., S. 44.
26	Roser,	“	Centralbl. f. Chirurgie, 1883.
27	Sands,	“	Medical Record, April 22, 1882.
28	Treves,	“	Intestinal Obstruction, etc., p. 499, 1884.
29	Watson,	“	Med. Times and Gazette, July 12, 1879.

TABLE III.—CASES OF LAPAROTOMY FOR STRANGULATION PERSISTING AFTER HERNIOTOMY OR REDUCTION OF HERNIA BY TAXIS.

No.	Operator or Reporter.	Result.	Reference.
1	Adelmann,	Died.	Prag. Vierteljahrschr., Bd. lxxviii. S. 55.
2	Annandale,	“	Brit. Med. Journ., Feb. 8, 1879.
3	Bell,	Recovered.	Ibid.
4	Billroth,	Died.	Archiv f. klin. Chir., Bd. i. S. 485.
5	Bourguet,	“	Archives Gén. de Méd., Oct. 1876.
6	Culbertson,	“	Private Letter.
7	Curling,	“	Lancet, vol. ii. p. 81, 1850.
8	Dieffenbach,	“	Op. Chirurgie, Bd. ii. S. 439.
9	Holmer,	“	Schmidt's Jahrbucher, Bd. clxxxviii. H. 3.
10	Jones,	“	Med. Times and Gazette, vol. ii. p. 182, 1854.
11	Larquet,	Recovered.	Adelmann, loc. cit., S. 46.
12	Leopold,	“	Ibid., S. 44.
13	McLeod,	Died.	Indian Med. Gazette, vol. xvii. p. 189, 1882.
14	Périer,[3]	“	Gazette Médicale, 12 Fév. 1881.
15	Pitts,	“	St. Thomas's Hosp. Reports, vol. xi.
16	Id.	“	Ibid.
17	Prieger,	Recovered.	Adelmann, loc. cit., S. 44.
18	Renault,	“	Archives Gén. de Méd., t. i. p. 458, 1845.
19	Servier,	Died.	Ibid., Juin, 1873.
20	Stokes,	“	Dublin Med. Journal, Nov. 1882.
21	Wood,	Recovered.	Western Lancet, vol. xiv. p. 720.

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[1] Perforation of bowel also from fecal concretion.

[2] Died subsequently from pneumonia.

[3] In case 14, a portion of intestine was resected.

TABLE IV.—CASES OF LAPAROTOMY FOR OBSTRUCTION DUE TO THE PRESENCE OF FOREIGN BODIES, GALL-STONES, IMPACTED FECES, ETC.

No.	Operator or Reporter	Result.	Reference.
1	Billroth,	Died.	Med. Times and Gazette, Sept. 25, 1880.
2	Bryant,	"	Ibid., Feb. 22, 1879.
3	Chaput,	Undeterm'd.	Progrès Médical, t. xi. p. 103, 1883.
4	Dowse,	Died.	Brit. Med. Journ., May 31, 1879.
5	Gentilhomme,	Recovered.	Un. Méd. et Sc. du Nord-est, t. v., 1881.
6	Id.[1]	Died.	Ibid., t. vii., 1883.
7	Johnston,[2]	Recovered.	Dublin Med. Journal, Aug. 1876.
8	Hill,	Died.	Med. Times and Gazette, Sept. 25, 1880.
9	Hill, W.	Recovered.	Boston Med. and Surg. Journ., June 29, 1882.
10	Ker,	Died.	Brit. Med. Journ., Nov. 26, 1881.
11	Langenbuch,	"	Lond. Med. Record, Aug. 15, 1880.
12	Lidén,	"	Schmidt's Jahrbücher, Bd. clxxxviii. H. 3.
13	Littlewood,	"	Lancet, Aug. 12, 1882.
14	Monro Primus,	"	Adelmann, Prag. Vierteljahrschr., Bd. lxxviii. S. 42.
15	Reali,	Recovered.	Prag. Vierteljahrschr., Bd. xxvi. S. 50 (Analekt.).
16	Spanton,	Died.	Brit. Med. Journ., May 28, 1881.
17	Studsgaard,	Recovered.	Ibid., Aug. 3, 1878.
18	Taylor,	Died.	Medical News, Aug. 30, 1884.
19	Thorndike,	Recovered.	Bost. Med. and Surg. Journ., Jan. 15, 1885.
20	Uhde,	"	Medical Record, July 29, 1882.
21	Verneuil,	"	Gazette Médicale, 29 Mai, 1880.
22	Walters,	Died.	Brit. Med. Journ., Nov. 6, 1880.
23	White,	Recovered.	Medical Repository, 1807.

TABLE V.—CASES OF LAPAROTOMY FOR OBSTRUCTION DUE TO INTERNAL STRANGULATION BY BANDS, ADHESIONS, OR DIVERTICULA.

No.	Operator or Reporter.	Result.	Reference.
1	Agnew,	Died.	Unpublished; Personal communication.
2	Anderson,	"	Med. Times and Gazette, vol. ii. p. 45, 1858.
3	Annandale,	"	Edinb. Med. Journ., vol. xvi. p. 700, 1871.
4	Ashhurst,	"	Unpublished.
5	Atherton,	Recovered.	Bost. Med and Surg. Journ., June 14, 1883.
6	Id.	Died.	Medical Record, April 12, 1884.
7	Id.	"	Ibid.
8	Baker,	"	St. Bartholomew's Hosp. Reports, vol. xvii. p. 277.
9	Bardeleben,	Recovered.	Medical News, June 27, 1885.
10	Berger,	Died.	Bull. et Mém. de la Soc. de Chirurgie, 3 Nov. 1880.
11	Berti,	Recovered.	Lond. Medical Record, Aug. 15, 1874.
12	Bœckel,	"	Gazette Médicale, 19 Juin, 1880.
13	Id.	"	Ibid., 21 Mai, 1881.
14	Borelli,	"	Whitall, New York Med. Journ., Aug. 1873.
15	Bouilly,	Died.	Gazette Médicale, 21 Avril, 1883, *et seq.*
16	Id.	"	Ibid.
17	Id.	"	Ibid.
18	Id.	"	Revue Méd. Française et Étrangère, 26 Juillet, 1884.
19	Briddon,	"	Medical Record, July 29, 1882.
20	Brodripp,	Recovered.	Lancet, May 16, 1885.
21	Bryant,	"	Med.-Chir. Trans., vol. l. p. 65.
22	Id.	Died.	Brit. Med. Journ., Nov. 22, 1884.
23	Id.	"	Ibid.
24	Id.	"	Ibid., Dec. 20, 1884.
25	Buckler,	"	Bost. Med. and Surg. Journ., Oct. 28, 1880.
26	Byrd,	Recovered.	Trans. Am. Med. Assoc., 1880, 1881.
27	Canton,	Died.	Lond. Med. Gazette, N. S., vol. xii. p. 78.
28	Cheever,	"	Boston City Hosp. Reports, vol. ii. p. 259.
29	Claudat,	"	Medical Record, Dec. 17, 1881.
30	Clutton,	Recovered.	Brit. Med. Journ., May 17, 1884.
31	Cowell,	"	Med. Times and Gazette, Dec. 9, 1876.
32	Creveling,	Died.	Bost. Med. and Surg. Journ., Feb. 27, 1879.

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[1] In case 6, a portion of intestine was resected.

[2] In case 7, the colon was opened.

TABLE V.—*Continued.*

No.	Operator or Reporter.	Result.	Reference.
33	Cripps,	Died.	Lancet, June 8, 1878.
34	Cruveilhier,	"	Gazette des Hôpitaux, 2 et 5 Nov. 1872.
35	Culbertson,	"	Letter from Operator.
36	Demarquay,	"	Desprès, Gazette Médicale, 30 Août, 1879.
37	Depaul,	"	Whitall, loc. cit.
38	Dowse,	Recovered.	Brit. Med. Journ., May 31, 1879.
39	Druitt,	Died.	Med.-Chir. Trans., vol. xxxi. p. 245.
40	Duplay,	"	Archives Gén. de Médecine, Nov. 1876.
41	Id.	"	Gazette Médicale, 26 Juillet, 1879.
42	Dupont,	Recovered.	Bull. de la Soc. Méd. de la Suisse Rom., 1880.
43	Dupuytren,	Died.	Leçons Orales, 2e éd., t. iii. p. 650.
44	Fergusson,	"	System of Practical Surgery, p. 651. 1870.
45	[Fincham],	"	Med. Times and Gazette, vol. ii. p. 651, 1876.
46	Fischer,	Recovered.	Adelmann, Prag. Vierteljahrschr., Bd. lxxviii. S. 46.
47	Folkersma,	"	Nederl. Tijdrschr. v. Geneesk, 1880.
48	Gay,	Died.	Trans. Path. Soc. Lond., vol. iii. p. 101.
49	Gerster,	"	Medical News, Jan. 27, 1883.
50	Gillette,	"	Union Médicale, 1883.
51	Gould,	"	Med. Times and Gazette, Nov. 8, 1884.
52	Greves and Pughe,	Recovered.	Med. Press and Circular, Nov. 12 and Dec. 3, 1884.
53	Halstead,	Died.	Medical News, Jan. 27, 1883.
54	Hancock,	"	Lond. Med. Gazette, N. S., vol. xii. p. 77.
55	Heath,	Recovered.	Lancet, June 10, 1876.
56	Heiberg,	Died.	Schmidt's Jahrbucher, Bd. clxxxviii. H. 3.
57	Heinitsh,	"	Virginia Med. Monthly, July, 1877.
58	Herff,	"	Menger, Journal of Materia Medica, April, 1877.
59	Hill,	"	Lancet, May 27, 1876.
60	Hilton,	"	Med.-Chir. Trans., vol. xxx. p. 51.
61	Holmes,	"	Surgical Treatment of Children's Diseases, 2d ed., p. 570.
62	Howse,	"	Guy's Hosp. Reports, 3d S., vol. xix.
63	Id.	Recovered.	Ibid.
64	Hulke,	Died.	Med. Times and Gazette, vol. ii. p. 482, 1872.
65	Id.	"	Brit. Med. Journ., Jan. 7, 1882.
66	Jacobson,	"	Jessop, Brit. Med. Journ., Sept. 27, 1879.
67	Jeannel,	Recovered.	Union Médicale, 31 Mars, 1885.
68	Jessop,	Died.	Brit. Med. Journ., May 31 and Sept. 27, 1879.
69	Jones,	"	Med. Times and Gazette, April 22, 1882.
70	Julliard,[1]	Recovered.	Bull. et Mém. de la Soc. de Chir. de Paris, p. 665, 1879.
71	Land,	"	Jessop, loc. cit.
72	Lawson,	Died.	Coupland, Med. Times and Gazette, May 19, 1883.
73	Lediard,	"	Lancet, Aug. 3, 1878.
74	Id.	"	Med. Times and Gazette, Oct. 25, 1844.
75	Le Fort,	Recovered.	Gazette Médicale, 11 Nov. 1882.
76	Lucas-Championniere,	Died.	Bull. Gén. de Thérapeutique, 30 Août, 1879
77	MacCormac,	"	Practitioner, vol. i., 1878.
78	McCormack,[2]	Recovered.	American Practitioner, Sept. 1879.
79	Macnamara,	Died.	Donkin, Med. Times and Gazette, May 10, 1884.
80	Malins,[2]	Recovered.	Brit. Med. Journ., Sept. 22, 1883.
81	Id.[2]	"	Ibid.
82	Manlove,	"	Bost. Med. and Surg. Journ., vol. xxxii. p. 492.
83	Marcacci,	"	Brit. Med. Journ., March 23, 1872.
84	Mason,	Died.	Medical Record, July 10, 1875.
85	Id.	"	Ibid., Jan. 22, 1881.
86	May,[3]	"	Lancet, Sept. 15, 1883.
87	Morisani,	"	Rev. Internaz. di Med. e Chir., tomo i. pag. 146.
88	Id.[4]	"	Ibid.
89	Mikulicz,	"	Annals of Surgery, Feb. 1885.
90	Nancrede,	"	Trans. Path. Soc. Phila., 1879.
91	Obalinsky,	"	Revue des Sciences Médicales, 15 Juillet, 1885.
92	Id.	"	Ibid.

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[1] In case 70, an ovarian tumor, to which the bowel was adherent, was removed.
[2] In cases 78, 80, and 81, the bowel was opened and a fistula established.
[3] In case 86, a fatal volvulus formed on the third day after the operation.
[4] In case 88, a portion of the bowel was exsected.

TABLE V.—*Concluded.*

No.	Operator or Reporter.	Result.	Reference.
93	O'Grady,	Died.	Brit. Med. Journ., April 13, 1878.
94	Parise,	“	Whitall, loc. cit.
95	Id.	“	Archives Gén. de Médecine, Nov. 1876.
96	Paterson,	Recovered.	Brit. Med. Journ., Nov. 20, 1880.
97	Patterson and Finlayson,	Died.	Practitioner, Dec. 1880.
98	Peck,	Undeterm'd.	Medical Record, June 17, 1882.
99	Pirogoff,	Died.	Adelmann, loc. cit., S. 44.
100	Polaillon,	Recovered.	Bull. Gén. de Thérapeutique, 30 Août, 1879.
101	Id.	Died.	Ibid.
102	Id.	Recovered.	Gazette Médicale, 25 Avril, 1885.
103	Pughe,	“	Lancet, Dec. 6, 1884, p. 1019.
104	Rigaud,	Died.	Archives Gén de Médecine, Nov. 1876.
105	Rivington,	“	Brit. Med. Journ., May 21, 1881.
106	Roworth,	Recovered.	Ibid., Dec. 6, 1884.
107	[Sands],	Died.	Medical Record, April 22, 1882.
108	Savory,	Recovered.	Alder Smith, Brit. Med. Journ., May 26, 1883.
109	Smith, T.	Died.	Brit. Med. Journ., Jan. 18, 1879.
110	Terrier,	Recovered.	Abeille Médicale, 4 Août, 1879.
111	Tessier,	Died.	British American Journal, vol. i. p. 251, 1860.
112	Trélat,	“	Gazette Médicale, 23 Août, 1879.
113	Treves,	“	Intestinal Obstruction, p. 108. London, 1884.
114	Id.	Recovered.	Ibid., p. 110.
115	Tripp,	“	Louisville Med. News, Jan. 17, 1885.
116	Voigt,	“	Prag. med. Wochenschrift, 1883.
117	Weinlechner,	Died.	Aertzl. Ber. der k.-k. allg. Krankenh. zu Wien, 1883.
118	Id.	“	Ibid.
119	Wells,	Recovered.	Lancet, July 14, 1877.

TABLE VI.—CASES OF LAPAROTOMY FOR OBSTRUCTION FROM TUMORS, STRICTURES, ULCERS, ETC.

No.	Operator or Reporter.	Result.	Reference.
1	Avery,	Died.	Trans. Path. Soc. Lond., vol. ii. p. 62.
2	Barié et Ducastel,	Undeterm'd.	Progrès Médical, 1880.
3	Berger,	Died.	Bull. et. Mém. de la Soc. de Chirurgie, 3 Nov. 1880.
4	Biesiadecki,	“	Brit. Med. Journ., Jan. 29, 1876.
5	Cameron,	“	Glasgow Med. Journ., April, 1879.
6	Davies-Colley,	“	Guy's Hosp. Reports, 3d S., vol. xix.
7	Duplay,	“	Gazette Médicale, 26 Juillet, 1879.
8	Gussenbauer,[1]	“	Hospital Gazette, Oct. 10, 1878.
9	Hamilton,	“	Med. Times and Gazette, vol. i. p. 88, 1864.
10	Homans,	Recovered.	Bost. Med. and Surg. Journ., Feb. 14, 1884.
11	Id.	Died.	Ibid.
12	Lawson,	“	Med. Times and Gaz., vol. i. p. 675, 1861.
13	Id.	Recovered.	Ibid., Jan. 18, 1879.
14	Le Fort,	Died.	Bull. Gén. de Thérapeutique, 30 Août, 1879.
15	Levis,	“	Personal communication.
16	Luke,	“	Trans. Path. Soc. Lond., vol. ii. p. 218.
17	MacCormac,[2]	Recovered.	Brit. Med. Journ., Jan. 14, 1882.
18	Marsh,[3]	“	Lancet, March 1, 1879.
19	Marshall,[4]	Died.	Ibid., April 22, 1882.
20	May,	“	Brit. Med. Journ., Feb. 24, 1883.
21	Mikulicz,	“	Archiv f. klin. Chirurgie, Bd. xxx.
22	Monod,	“	Archives Gén. de Méd., t. ii. p. 455, 1838.
23	Mynter,[3]	“	Buffalo Med. and Surg. Journ., vol. xix. p. 347.
24	Pagenstecher,	Recovered.	Archiv f. klin. Chirurgie, Bd. ii. S. 318.
25	Partsch,	Died.	Centralbl. f. Chir., Bd. x. S. 833.

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[1] In case 8, a portion of small intestine was exsected.
[2] In case 17, hysterectomy was also performed.
[3] In cases 18 and 23, the bowel was opened.
[4] In case 19, a portion of large intestine was exsected.

TABLE VI.—*Concluded.*

No.	Operator or Reporter.	Result.	Reference.
26	Pitts,[1]	Recovered.	St. Thomas's Hosp. Reports, vol. xi.
27	Reybard,	“	Bull. de l'Acad. de Méd., t. ix. p. 1031.
28	Richter,[2]	“	Med. News, Sept. 30, 1882.
29	Roser,[1]	Died.	Brit. Med. Journ., Sept. 27, 1879.
30	Tait,	Undeterm'd.	Med. Times and Gazette, Nov. 26, 1881.
31	Teale,[1]	Recovered.	Lancet, March 13, 1875.
32	Id.	Died.	Brit. Med. Journ., Jan. 11, 1879.
33	Id.	“	Ibid.
34	Id.	“	Ibid.
35	Id.	“	Ibid.
36	Id.	“	Ibid.
37	Tillaux,	Recovered.	Gazette Médicale, 21 Août, 1880.

TABLE VII.—CASES OF LAPAROTOMY FOR OBSTRUCTION DUE TO HERNIÆ OF VARIOUS FORMS AND TO “ILEUS.”

No.	Operator or Reporter.	Result.	Reference.
1	Annandale,[3]	Died.	Edinb. Med. Journal, Sept. 1873.
2	Bellamy,[4]	Recovered.	Trans. Clin. Society, vol. xii.
3	Berger,	Died.	Bull. et Mém. de la Soc. de Chirurgie, 3 Nov. 1880.
4	[Blancard],	Recovered.	Mém. de l'Acad. Royale de Chirurgie, t. iv. p. 337.
5	Blum,[5]	“	Bull. et Mém. de la Soc. de Chirurgie, 10 Nov. 1880.
6	Bradley,	Died.	Lancet, April 6, 1878.
7	Briddon,	“	Medical Record, May 15, 1880, and July 29, 1882.
8	Byrd,	Recovered.	Trans. Am. Med. Assoc., 1880, 1881.
9	Coulson,[6]	Died.	Lancet, vol. ii. p. 303, 1863.
10	Dandridge,[7]	“	Cinc. Lancet and Clinic, Jan. 27, 1883.
11	Hilton,[6]	“	Med.-Chir. Trans., vol. xxxi. p. 323.
12	Id.	“	Association Med. Journal, May 12, 1854.
13	Hutchinson, E.	Undeterm'd.	Ohio Med. and Surg. Journal, vol. iii. p. 499.
14	Julliard,[8]	Recovered.	Gaz. Méd.-Chir. de Toulouse, t. xiii. pp. 193, 201.
15	Kiralyfi,[3]	Died.	Pest. med.-chir. Presse, Bd. xv. S. 675, 695.
16	Kurz,	Recovered.	Deutsch. med. Wochenschr., 26 Marz, 1885.
17	Marsh,	Died.	St. Barth. Hosp. Reports, vol. xvi. p. 57.
18	May,	“	Brit. Med. Journal, Feb. 24, 1883.
19	Neuber,	Recovered.	Archiv f. klin. Chirurgie, Bd. xxvi. S. 509.
20	Obalinski,	Died.	Wiener med. Presse, 1885.
21	Pauli,	“	Adelmann, Prag. Vierteljahrschr., Bd. lxxviii. S. 44.
22	Phillips,	“	Lond. Med. Gazette, N. S., vol. xiii. p. 233.
23	Pitts,	“	St. Thomas's Hosp. Reports, vol. xi.
24	Terrier,	Recovered.	Gazette Médicale, 22 Juin, 1878.
25	Trélat,	Died.	Bull. et Mém. de la Soc. de Chirurgie, 3 Nov. 1880.
26	Weinlechner,	“	Aertzl. Ber. d. k.-k. allg. Kr. zu Wien, S. 233, 1882.

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[1] In cases 26, 29, and 31, the bowel was opened.
[2] In case 28, a portion of large intestine was exsected.
[3] Cases 1 and 15 were examples of umbilical hernia; in case 15 the bowel was opened.
[4] In case 2, the patient died in six weeks, the wound being healed.
[5] Case 5 was an example of inguinal hernia.
[6] Cases 9 and 11 were examples of obturator hernia.
[7] In case 10, there was also a volvulus.
[8] In case 14, a portion of bowel was exsected.

TABLE VIII.—CASES OF LAPAROTOMY FOR OBSTRUCTION DUE TO VARIOUS CAUSES.

No.	Operator or Reporter.	Result.	Reference.
1	Adelmann,[1]	Died.	Prag. Vierteljahrschr., Bd. lxxviii. S. 42.
2	Arnison,[2]	"	Brit. Med. Journal, Dec. 31, 1881.
3	Brodie,[1]	"	Lancet, vol. xii. p. 502, 1827.
4	Koeberle,[3]	Recovered.	Medical Record, July 14, 1877.
5	Mazzini,[4]	"	Lond. Med. Record, July 15, 1884.
6	Parkes,[5]	"	Chicago Med. and Surg. Examiner, 1883.
7	Rosenbach,[6]	Died.	Gazette Médicale, 19 et 26 Août, 1882.

TABLE IX.—CASES OF LAPAROTOMY FOR OBSTRUCTION DUE TO UNDETERMINED CAUSES.

No.	Operator or Reporter.	Result.	Reference.
1	Bricheteau,	Died.	Desprès, Gazette Médicale, 30 Août, 1879.
2	Burchard,	"	Medical Record, April 12, 1884.
3	Id.	Recovered.	Ibid.
4	Id.	Died.	Ibid.
5	Favell,[7]	"	Brit. Med. Journal, Feb. 16, 1884.
6	Fincham and Macnamara,	Recovered.	Lancet, vol. i. p. 988, 1881.
7	Fuqua,[8]	Died.	American Practitioner, June, 1884.
8	Gallozzi,	Recovered.	Gazz. Med. Ital. Lomb., tomo iv. pag 425.
9	Id.	"	Resoc. Accad. Med.-Chir. de Napoli, 1883.
10	Gosselin,	Died.	Desprès, loc. cit.
11	Janel,	Recovered.	Gazette Médicale, 26 Mars, 1881.
12	Jessop,	Died.	Brit. Med. Journal, Sept. 27, 1879.
13	Id.	"	Ibid.
14	Malgaigne,	"	Le Fort, Medical Record, Feb. 24, 1883.
15	Seymour,	Undeterm'd.	Medical Record, vol. xv. p. 321, 1879.
16	Tait,[9]	Recovered.	Brit. Med. Journal, Nov. 26, 1881.
17	Id.[10]	Died.	Med. Times and Gazette, Aug. 2, 1884.
18	Tibaldi,	"	Gaz. d. Osp., Milano, 1880.
19	Treves,[11]	"	Lancet, Dec. 16, 1882.

[1] In cases 1 and 3, the obstruction was caused by prolapsus of small intestine through a laceration of the rectum.

[2] In case 2, the obstruction was due to a ruptured aneurism of the hepatic artery.

[3] In case 4, the obstruction was caused by a retroverted uterus.

[4] In case 5, the obstruction was caused by typhlitis and consequent abscess.

[5] In case 6, the obstruction was caused by a retro-peritoneal abscess.

[6] In case 7, the obstruction was caused by an abscess of the pancreas.

[7] In case 5, gangrenous enteritis was found, supposed to be due to embolism.

[8] In the Journal of the American Medical Association, Sept. 15, 1883, Dr. Fuqua refers to two fatal cases of laparo-enterotomy.

[9] In the Medical Times and Gazette for November 26, 1881, Mr. Tait is reported to have said that he had performed seven laparotomies for intestinal obstruction, and had only once found the cause of the disease—in this instance a malignant growth. (See Table VI.)

[10] In case 17, the bowel was opened.

[11] In case 19, a portion of the large intestine was exsected.

ENTEROTOMY.—This operation was particularly recommended by Nélaton, as a remedy for acute obstruction, and hence is often known by his name. It was also a favorite operation with the late Mr. Maunder, of the London Hospital, and, as already mentioned, is advised by Mr. Bryant in cases of intussusception for which laparotomy appears unsuited. Mr. Banks, of Liverpool, prophesies that it will be the "operation of the future." The operation consists in making an incision, usually in the right iliac region, and opening the first distended coil of intestine which presents itself. The wound is made parallel to Poupart's ligament and outside of the line of the internal epigastric artery. The external incision should be nearly three inches in length, and the opening in the peritoneum about an inch and a half. The bowel having been exposed, it is drawn gently into the wound, and is fixed to either lip by a row of silk sutures which include the whole thickness of the intestinal wall. A small incision is finally made between the stitches. It is sometimes advised that the operation should be divided into two stages, the bowel being first secured to the external wound, and then opened several days afterwards; but I can hardly conceive of a case in which this delay would be permissible, in which the operation would be justifiable at all: enterotomy is an operation for acute, and not for chronic obstruction.

This operation is undoubtedly a simpler, and, except in cases of malignant disease, probably a somewhat less dangerous one than laparotomy, but, on the other hand, can in most cases serve only as a palliative or euthanasial measure. It might effect a cure in some rare cases of volvulus, and might afford time for recovery by sloughing in some cases of intussusception, but obviously could not be expected to give permanent relief in cases of internal strangulation. Its statistics have been investigated by Peyrot, who has tabulated 86 cases, to which Mr. Treves has added a summary of 23 more. Of the whole 109 cases, 26 are said to have ended in recovery and 83 in death, a mortality of 76 per cent. But if cases of malignant disease are excluded, 61 operations gave 20 recoveries and only 41 deaths, a mortality of but 67 per cent.

As an operation secondary to laparotomy, enterotomy may be required in cases of obstruction by a foreign body or gall-stone, stricture of the intestine, irreducible invagination, etc. The operation then receives the name of *laparo-enterotomy*. It may also be resorted to in certain cases of lumbar colotomy, when, after the colon has been opened, it is found that the obstruction is at a higher point. Under these circumstances it may be the best practice, as advised by Mr. Morris and Dr. Coupland, to open the peritoneum through the lumbar wound, draw out a coil of small intestine, and make it the seat of an artificial anus rather than make a second wound elsewhere.

COLOTOMY, an operation designed to establish an artificial anus in the colon, may be performed in different ways. Thus, the sigmoid flexure may be opened in the left iliac region (as originally suggested by Littre in 1710), or the cæcum in the right iliac region (Pillore, 1776); the same parts respectively may be opened in the left loin (Callisen, 1796), or in the right loin; or finally the transverse colon may be opened in the neighborhood of the umbilicus (Fine, 1797). The choice of one or other of these procedures should be governed mainly by the nature of the case for which the operation is required. Thus, for congenital defects of the anus or rectum, when the gut cannot be reached from the perineum, Littre's method (left inguinal colotomy) is usually to be preferred; for strictures or ulcers of the rectum, resto-vesical fistulæ, etc., Callisen's method as improved by Amussat (left lumbar colotomy), is the operation to be recommended; for stricture, or other form of obstruction in the large intestine at any point higher than the rectum, right lumbar colotomy is the best procedure, unless in exceptional cases, as, for instance, when there is congenital absence of the entire rectum and sigmoid flexure, in an infant, under which circumstances Pillore's method (right inguinal colotomy) may be preferred. Fine's operation (umbilical colotomy) seems to present no advantage over those of his predecessors.

Callisen's or Amussat's Operation—it is now generally known by the name of the later writer—consists in opening the colon in the left lumbar region (*left lumbar colotomy*). The following directions for its performance are based upon those given by Mr. Allingham, which are founded upon the experience derived from more than fifty dissections, and from a very large number of cases in which that surgeon has employed the operation. Anæsthesia having been induced, the patient is fixed in the prone position with a slight inclination towards the right side, a hard pillow being placed under the left side, so as to render the loin tense and prominent. To determine the exact position of the colon, a point on the crest of the ilium, midway between the anterior superior and posterior superior spinous processes, is marked with iodine paint, the colon in the normal condition being always situated half an inch behind the point thus indicated. The surgeon then, standing in front of the patient, makes an incision of at least four inches, midway between the last rib and the crest of the ilium, the centre of the wound corresponding exactly with the point which has been marked. The wound may be transverse, as recommended by Amussat, or, which is better, oblique, downwards and forwards in the course of the ribs, as advised by Mr. Bryant. The various tissues are carefully divided to the full extent of the external wound, until the lumbar fascia and edge of the quadratus lumborum muscle have been reached; the former being cut through, the colon usually presents itself at once, and may commonly be recognized, even if undistended, by the appearance of one of its longitudinal bands. Care must be taken not to open the peritoneum, which is sometimes inflated with gas and in its appearance simulates the bowel. The operation is completed by introducing with a curved needle strong silken sutures, by means of which the gut is drawn to the surface, when it is incised in the direction of its long axis to the extent of about an inch; the margins of the intestinal aperture are then stitched to the edges of the external wound, the sutures being retained until they begin to cut their way through by ulceration.

If the case be not a very urgent one, it may be well, as advised by Costallat, to divide the operation into two stages, and not to open the colon until several days after its exposure.

In order to prevent the annoyance and distress which often follow the accumulation of fecal matter in the colon below the opening, Madelung has suggested a modification of the ordinary operation, consisting in cutting the gut completely across, the upper end being then fixed to the lips of the external incision, while the lower end is carefully closed with sutures and dropped into the wound.

Right lumbar colotomy, in which the cæcum is opened instead of the sigmoid flexure, is performed in the same way as Amussat's operation, except that the incision is made in the right instead of in the left loin. In order to determine on which side the colon should be opened, Mr. T. P. Teale recommends that a median laparotomy should be first performed as an exploratory measure—an addition to the operation which I confess seems to me quite unjustifiable.

Littre's operation (*inguinal colotomy*), which is preferred to Amussat's by Studsgaard, Reeves, Verneuil, Reclus, and some other surgeons, but which seems to me less desirable except in cases of congenital absence of the rectum, etc., is a simpler procedure than the other, particularly in children.

It consists in making an incision from two to three inches in length, parallel to and a little above the line of Poupart's ligament, and midway between the anterior superior spinous process of the ilium and the spine of the pubis. The tissues having been cautiously divided as in enterotomy, the colon is drawn forwards, and is opened as it is in Amussat's method. This operation, in cases of rectal stricture, is usually performed on the left side, opening the sigmoid flexure; but when required for obstruction of the colon it should be practised on the right side, opening the cæcum. Verneuil has modified Littre's operation by making the incision in the direction of a line drawn from the umbilicus to the junction of the outer and middle thirds of Poupart's ligament, resecting instead of simply incising the colon, and making a section of the part, so as to allow the formation of an *éperon* to prevent the entrance of fecal matter into the lower segment of the bowel.

The great advantage of Amussat's over Littre's operation is in the circumstance, that by the lumbar incision the abdominal cavity is not opened, the colon being approached on that side which is not covered by peritoneum. The operation is comparatively easy when the bowel is distended with fecal matter, but under opposite conditions, as when it is performed for stricture without obstruction, it may be attended with considerable difficulty; in such a case it would be well to distend the bowel with air before beginning the operation, so as, if practicable, to render the position of the colon more apparent. Some trouble is commonly experienced at first from prolapsus of the bowel through the artificial anus, but as the parts contract in healing, the tendency to protrude is lessened, and it may even become necessary at last to adopt means to keep the artificial anus patulous. To prevent protrusion, Dr. Maclaren employs an "enterotomy tube" which somewhat resembles the supra-pubic vesical tube formerly employed by Sir Henry Thompson in cases of inveterate prostatic hypertrophy. In order to protect the clothing and prevent the escape of fecal matter at inconvenient times, an obturator may be worn, composed of ivory or hard rubber, fastened to a plate of similar material, and held in place with a truss or bandage.

The *statistics* of colotomy have been particularly investigated by Hawkins, Mason, Bulteau, Van Erckelens, and W. R. Batt, of Philadelphia, who has collected and analyzed no less than 351 cases, a much larger number than has hitherto been brought together. Dr. Batt's researches were made on my suggestion, in 1884, as the subject of an inaugural thesis which was deemed worthy of a prize, and I am permitted to avail myself of them in this article. His tables, which are very elaborate, contain a great many interesting particulars which I am obliged to omit for want of space. The individual records of Mr. Allingham, Mr. Bryant, and Mr. Reeves, are probably larger than those of any other surgeons: of 69 terminated cases recorded by the first-named writer up to the year 1884, only two ended fatally as the direct result of the operation, and of 53 cases recorded by the last-named only seven; but 82 cases in Mr. Bryant's hands gave 33 deaths (within one month), and only 49 more or less permanent recoveries.

TABLE X.—SHOWING THE RESULTS OF 154 CASES OF COLOTOMY FOR CANCER OF THE BOWEL.

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
1	Adams,	Littre.	Recovered.	Lond. Hosp. Reports, vol. ii.
2	Id.	"	"	Med.-Chir. Trans., vol. xxxv.
3	Id.	Amussat.	"	Lancet, vol. i., 1852.
4	Agnew,	"	"	Personal communication.
5	Allingham,	"	"	St. Thomas's Hosp. Reports, N. S., vol. i.
6	Id.	"	"	Ibid.
7	Id.	"	"	Ibid.
8	Id.	"	"	Ibid.
9	Id.	"	Died.	Ibid.
10	Id.	"	Recovered.	Ibid.
11	Id.	"	"	Ibid.
12	Id.[1]	"	"	Ibid.
13	Amussat,	"	"	Gazette Médicale de Paris, 1839.
14	Id.	"	"	Oesterr. med. Wochenschrift, 1842.
15	Id.	"	Died.	
16	Id.	"	Recovered.	Gazette Médicale de Paris, 1844.
17	Anderson,	"	"	Glasgow Med. Journal, N. S., vol. v.
18	Andrews,	"	"	Chicago Med. and Surg. Examiner, vol. xxxiii.
19	Arnott,	"	"	Trans. Path. Soc. Lond., vol. xxvi.
20	Ashmead,	Callisen.	Died.	Trans. Coll. Phys. Phila., 1842.
21	Baker,	Amussat.	Recovered.	Med.-Chir. Trans., vol. xxxv.
22	Id.	"	Died.	British Med. Journal, vol. ii., 1880.
23	Barwell,	"	Recovered.	Trans. Clin. Soc. Lond., vol. xii.
24	Blackman,	"	"	Cincinnati Journ. of Med., 1866.
25	Id.	"	"	Ibid.
26	Briddon,	"	"	Medical Record, 1878.
27	Id.	"	"	Ibid., 1873.
28	Id.	"	"	Ibid., 1880.
29	Bryant,	"	"	Lancet, vol. ii., 1875.
30	Id.	"	"	Ibid.
31	Id.	"	"	Ibid., vol. i., 1870.
32	Id.	"	"	Ibid., 1874.
33	Id.	"	Died.	Ibid., vol. i., 1881.
34	Id.	"	Recovered.	Ibid.
35	Id.[2]	"	"	Ibid.
36	Busch,	"	Died.	Dublin Med. Press, vol. xxiii.
37	Id.	Littre.	Recovered.	Van Erckelens, Archiv f. klin. Chir., Bd. xxiii.
38	Id.	"	"	Ibid.
39	Id.	"	Died.	Ibid.
40	Id.	"	"	Ibid.
41	Callender,	Amussat.	Recovered.	Trans. Clin. Soc. Lond., vol. iii.
42	Id.	"	"	Lancet, vol. ii., 1869.
43	Carter,	"	"	London Hosp. Reports, vol. iv.
44	Cayley and Lawson,	"	"	Brit. Med. Journal, vol. i., 1877.
45	Id.	"	"	Ibid.
46	Clarkson,	"	"	Med.-Chir. Trans., vol. xxxiii.
47	Coskery,	"	"	Maryland Med. Journal, vol. v.
48	Critchett,	"	Died.	Lond. Hosp. Reports, vol. iii.
49	Curling,	"	Recovered.	Ibid.
50	Id.	"	Died.	Ibid.
51	Id.	"	Recovered.	Ibid.
52	Id.	"	"	Ibid.
53	Id.	"	"	Ibid.
54	Id.	"	Died.	Ibid.
55	Id.	"	Recovered.	Ibid., vol. iv.
56	Id.	"	Died.	Ibid.
57	Id.	"	"	Trans. Path. Soc. Lond., vol. xxii.
58	Didot,	"	Recovered.	Bull. de l'Acad de Méd. de Belgique, 1846–1847.
59	Dowse,	"	Died.	Trans. Path. Soc. Lond., vol. xxiv.

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[1] Mr. Allingham's total experience in colotomy embraces 69 cases.

[2] Mr. Bryant's total experience in colotomy embraces 82 cases.

TABLE X.—*Continued.*

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
60	Dreffin,	Littre.	Died.	Trans. Path. Soc. Lond., vol. xix.
61	Durham,	Amussat.	“	Lancet, vol. ii., 1864.
62	Edwards,	“	Recovered.	Leavenworth Med. Herald, vol. iii.
63	Elder,	“	“	Lancet, vol. i., 1883.
64	Id.	“	“	Ibid.
65	Id.	“	Died.	Ibid.
66	Id.	“	Recovered.	Ibid.
67	Erichsen,	“	Died.	Ibid., vol. i., 1857.
68	Field,	“	Recovered.	Med.-Chir. Trans., vol. xxxiii.
69	Fine,	Fine.	“	Recueil Périod. de la Soc. de Méd. de Paris, t. iii., [1797.
70	Forster,	Not stated.	“	Guy's Hosp. Reports, 3d S., vol. xiv.
71	Id.	Callisen.	Died.	Ibid.
72	Gläser,	Littre.	Recovered.	Archiv f. klin. Chirurgie, Bd. ix.
73	Gunn,	Amussat.	“	Medical Record, vol. i. 1879.
74	Harrison,	“	“	Lancet, vol. i., 1878.
75	Hawkins,	“	“	Med.-Chir. Trans., vol. xxxv.
76	Heath,	“	Died.	Brit. Med. Journal, 1872.
77	Id.	“	“	Ibid.
78	Id.	“	“	Ibid.
79	Id.	“	Recovered.	Ibid.
80	Id.	“	“	Ibid.
81	Id.	“	“	Ibid.
82	Id.	“	Died.	Ibid.
83	Id.	“	“	Med. Times and Gazette, 1874.
84	Id.	“	Recovered.	Ibid.
85	Id.	“	“	Brit. Med. Journal, 1876.
86	Id.	Callisen.	Undeterm'd.	Med. Times and Gazette, 1871.
87	Hewett,	Amussat.	Recovered.	Lancet, vol. i., 1869.
88	Hilton,	“	Died.	Guy's Hosp. Reports, 3d S., vol. iii.
89	Holmer,	Littre.	“	Nord. med. Arkiv, Bd. vi., 1874.
90	Id.	“	“	Ibid.
91	Id.	“	“	Ibid.
92	Id.	“	“	Ibid.
93	Hopgood,	Amussat.	Recovered.	Lancet, vol. ii., 1883.
94	Howe,	“	“	New York Med. Journal, vol. xxix.
95	Howse,	“	“	Med. Times and Gazette, 1872.
96	Hulke,	“	“	Lancet, 1872.
97	Id.	“	“	Med. Times and Gazette, vol. i., 1879
98	Id.	“	“	Ibid.
99	Jackson,	“	“	Chicago Med. Journal, vol. xxviii.
100	Jukes,	“	Died.	Provinc. Med. and Surg. Journal, vol. iv.
101	Kuster,	“	“	Five Years in Augusta Hospital, Berlin, 1877.
102	Laffan,	“	Recovered.	Dublin Quart. Journ. Med. Science, 1872.
103	Lantour,	“	“	Lancet, 1876.
104	Leijer,	Littre.	“	Hygiea, 1872.
105	Lucas,	Amussat.	“	Lancet, vol. ii., 1873.
106	Luke,	Littre.	Died.	Gazette Médicale de Paris, 1848.
107	McCarthy,	“	Recovered.	Med.-Chir. Trans., vol. lv.
108	McLaren,	Amussat.	“	Lancet, vol. ii., 1880.
109	Maisonneuve,	“	“	Bull. de la Soc. de Chirurgie, 1849.
110	Malgaigne,	“	Died.	Oesterr. med. Wochenschrift, 1842.
111	Id.	“	“	Lancet, vol. ii., 1844.
112	Marshall,	“	Recovered.	Med. Times and Gazette, vol. i., 1877.
113	Id.	“	“	Ibid.
114	Mason,	“	Died.	Am. Journ. Med. Sciences, N. S., vol. lvi.
115	Id.	“	Recovered.	Ibid.
116	Maunder,	“	“	Med. Times and Gazette, 1869.
117	Id.	“	“	Brit. Med. Journal, 1869.
118	Id.	“	“	Med. Times and Gazette, 1870.
119	Id.	“	“	Ibid.
120	Id.	“	Died.	Lond. Hosp. Reports, vol. iv.
121	Maury,	“	Recovered.	Medical Record, vol. i., 1879.
122	Monod,	Littre.	Died.	Archives Gén. de Médecine, 3e s., t. ii., 1838.
123	Montgomery,	Amussat.	Recovered.	Med. and Surg. Reporter, vol. xliii.
124	Morton,	“	Died.	Phila. Med. Times, vol. vii.
125	Morris,	“	Recovered.	Brit. Med. Journal, vol. i., 1879.

TABLE X.—*Concluded.*

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
126	Morris,	Amussat.	Recovered.	Brit. Med. Journal, vol. i., 1879.
127	Id.	"	"	Ibid.
128	Id.	"	Died.	Ibid.
129	Id.	"	Recovered.	Ibid.
130	Pagenstecher,	Littre.	"	Archiv f. klin. Chirurgie, Bd. xi.
131	Paget,	Amussat.	Died.	Lancet, vol. i., 1852.
132	Id.	"	Recovered.	Ibid., vol. i., 1870.
133	Pemberton,	"	Died.	Med. Times and Gazette, 1865.
134	Pillore,	Littre.	"	Tüngel, Ueber kunstliche Afterbildung, 1853.
135	Pooley,	Callisen.	"	New York Med. Journal, 1874.
136	Reeves,[1]	Amussat.	"	Med. Times and Gazette, 1878.
137	Id.	"	Recovered.	Ibid.
138	Richet,	Littre.	"	De l'opportunité de l'Anus Artificial, etc., Paris, [1875.
139	Id.	"	"	Ibid.
140	Id.	"	"	Ibid.
141	Sands,	Amussat.	Died.	Van Erckelens, loc. cit.
142	Id.	"	Recovered.	Mason, Am. Journ. Med. Sciences, vol. lvi.
143	Santee,	"	Died.	Episcopal Hospital Record.
144	Sheen,	"	Recovered.	Lancet, vol. ii., 1880.
145	Taylor,	"	"	Ibid., vol. ii., 1874.
146	Teale,	"	Died.	Oppenheimer's Zeitschrift, Bd. xxii.
147	Thierry,	Littre.	"	Ibid.
148	Thompson,	Amussat.	Recovered.	Med. Times and Gazette, vol. ii., 1868.
149	Id.	"	"	Brit. Med. Journal, vol. ii., 1868.
150	Velpeau,	Not stated.	Died.	Tüngel, op. cit.
151	Verneuil,	Littre.	Recovered.	Richet, op. cit.
152	Walters,	Amussat.	"	Brit. Med. Journal, vol. i., 1879.
153	Id.	"	"	Ibid.
154	Ward,	"	"	Lond. Hosp. Reports, vol. iii.

TABLE XI.—SHOWING THE RESULTS OF 20 CASES OF COLOTOMY FOR INTESTINAL FISTULA.

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
1	Bryant,	Amussat.	Died.	Med. Times and Gazette, 1868.
2	Id.	"	Recovered.	Ibid., 1872.
3	Id.	"	"	Trans. Clin. Soc. Lond., vol. v.
4	Id.	"	"	Med. Times and Gazette, 1869.
5	Id.	"	"	Manual for the Practice of Surgery.
6	Curling,	"	"	Med.-Chir. Transactions, vol. xxxv.
7	Daguesceau,	Littre.	"	Med. Times and Gazette, 1844.
8	Desgranges,	Not stated.	"	Tüngel, op. cit.
9	Elder,	Amussat.	"	Lancet, vol. i., 1883.
10	Hakes,	Not stated.	"	Schmidt's Jahrbucher, 1870.
11	Heath,	Amussat.	"	Van Erckelens, loc. cit.
12	Id.	"	"	Med. Times and Gazette, 1873.
13	Holmes,	"	"	Lancet, 1867.
14	Kuster,	"	"	Op. cit.
15	Mason,	"	"	Am. Journ. Med. Sciences, N. S., vol. lvi.
16	Maunder,	"	"	Med. Times and Gazette, 1869.
17	Id.	"	"	Brit. Med. Journal, 1869.
18	Tiffany,	"	"	Am. Journ. Med. Sciences, N. S., vol. lxxiv.
19	Tüngel,	"	Died.	Archiv f. klin. Chirurgie, Bd. i.
20	Weir,	"	Recovered.	New York Medical Journal, vol. xxv.

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[1] Mr. Reeves's total experience in colotomy embraces 53 cases.

TABLE XII.—SHOWING RESULTS OF 52 CASES OF COLOTOMY FOR IMPERFORATE RECTUM.

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
	Amussat,	Amussat.	Recovered.	Schmidt's Jahrbucher, Bd. iii.
2	Id.	"	Died.	Ibid.
3	Id.	"	Recovered.	Ibid.
4	Id.	"	"	Oesterr. med. Wochenschrift, 1842.
5	Ayres,	"	"	New York Journ. of Med., 3d S., vol. ii.
6	Baker,	"	"	Trans. Clin. Soc. Lond., vol. xii.
7	Bizet,	Littre.	Died.	Tüngel, op. cit.
8	Id.	"	Recovered.	Ibid.
9	Bougon,	Amussat.	Died.	Lancette Française, Déc. 1828.
10	Bryant,	Callisen.	Recovered.	Schmidt's Jahrbucher, Bd. iii.
11	Busch,	Littre.	"	Van Erckelens, loc. cit.
12	Croasdale,	Amussat.	Died.	Personal communication.
13	Curling,	"	"	Lancet, vol. i., 1857.
14	Id.	Callisen.	"	Med.-Chir. Trans., vol. xliii.
15	Id.	"	"	Ibid.
16	Desault,	Littre.	"	Tüngel, op. cit.
17	Dorrington,	Amussat.	"	Provinc. Med. and Surg. Journal, 1850.
18	Dubois,	Littre.	"	Tüngel, op. cit.
19	Dupuytren,	"	"	Leçons Orales, t. iii.
20	Duret,	"	Recovered.	Schmidt's Jahrbucher, Bd. iii.
21	Id.	"	Died.	Tüngel, op. cit.
22	Elkington,	Amussat.	"	Brit. Med. Journal, vol. ii., 1878.
23	Freer,	Littre.	Recovered.	Lond. Med. and Phys. Journal, vol. xlv.
24	Gardiner,	"	"	Canada Med. and Surg. Journal, 1876.
25	Goyrand,	"	"	Schmidt's Jahrbucher, Bd. iii.
26	Green,	"	"	Ibid.
27	Guersant,	Callisen.	Died.	Ibid.
28	Hasse,	Littre.	Recovered.	Tüngel, op. cit.
29	Jacobi,	"	Died.	Am. Journ. Obstetrics, vol. viii.
30	Johnson,	"	"	Schmidt's Jahrbucher, Bd. iii.
31	Klewitz,	"	Recovered.	Tüngel, op. cit.
32	Legris,	"	Died.	Ibid.
33	Lenoir,	"	"	Schmidt's Jahrbucher, Bd. iii.
34	Lepestre,	"	Recovered.	Ibid.
35	Leslie and Pennell,	Callisen.	Died.	Ibid.
36	Miriel,	Littre.	Recovered.	Tüngel, op. cit.
37	Id.	"	"	Ibid.
38	Id.	"	"	Ibid.
39	Ouvrard,	"	Undeterm'd.	Ibid.
40	Post,	Amussat.	Recovered.	Amer. Journ. Obstet., vol. viii.
41	Ranke,	Littre.	Died.	Jahrbuch. f. Kinderheilkunde, Bd. ix.
42	Id.	"	Recovered.	Ibid.
43	Rochard,	"	Died.	Schmidt's Jahrbucher, Bd. iii. Nachtrag.
44	Roux,	Not stated.	"	Van Erckelens, loc. cit.
45	Id.	Littre.	"	Gazette des Hôpitaux, 1841.
46	Serrand,	"	Recovered.	Tüngel, op. cit.
47	Scheck,	"	Died.	Van Erckelens, loc. cit.
48	Schlagentweit	"	"	Tüngel, op. cit.
49	Textor,	"	"	Krit. Repert. f. d. ges. Heilk., Bd. xx.
50	Tüngel,	"	Recovered.	Op. cit.
51	Id.	"	"	Ibid.
52	Voisin,	"	Died.	Rec. Périod. de la Soc. de Méd. de Paris, t. xxi.

TABLE XIII.—SHOWING THE RESULTS OF 40 CASES OF COLOTOMY FOR “OBSTRUCTION OF THE BOWEL.”

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
1	Amussat,	Amussat.	Recovered.	Oesterr. med. Wochenschrift, 1842.
2	Avery,	“	Undeterm'd.	Trans. Path. Soc. Lond., vol. iv.
3	Baudens,	“	Died.	Gaz. des Hôpitaux, 1842.
4	Bell,	Littre.	“	Lancet, vol. i., 1876.
5	Bott,	Amussat.	Recovered.	Brit. Med. Journal, 1870.
6	Bramwell,	Littre.	Died.	Glasgow Med. Journal, 1872.
7	Bryant,	Amussat.	“	Lancet, vol. ii., 1875.
8	Id.	“	“	Med. Times and Gazette, 1872.
9	Id.	“	Recovered.	Ibid.
10	Busch,	Littre.	Died.	Van Erckelens, loc. cit.
11	Clement,	Amussat.	Recovered.	Med.-Chir. Transactions, vol. xxxv.
12	Id.	“	“	Ibid.
13	Danzel,	Littre.	Died.	Archiv f. d. ges. Medicin, Bd. ix.
14	Dolbeau,	Not stated.	“	Progrès Médical, 1876.
15	Donand,	Littre.	“	Bordeaux Médical, 1872.
16	Gay,	Amussat.	“	Trans. Path. Soc. Lond., vol. v.
17	Holmer,	Littre.	Recovered.	Nord. med. Arkiv, Bd. vi.
18	Holmes,	Amussat.	“	Med.-Chir. Transactions, vol. xlix.
19	Hunter,	“	Died.	Oppenheim's Zeitschrift, Bd. xli.
20	Jobert,	“	“	Lancet, vol. i., 1857.
21	Jordan,	“	Recovered.	Ibid., vol. ii., 1874.
22	Leijer,	Littre.	Died.	Hygiea, 1872.
23	Lewis,	Amussat.	Recovered.	Schmidt's Jahrbucher, 1874.
24	Id.	“	“	Mason, Am. Journ. Med. Sci., N. S., vol. lxvi.
25	Mackenzie,	“	Died.	Med. Times and Gazette, 1877.
26	Manlove,	Fine.	Recovered.	Van Erckelens, loc. cit.
27	Maunder,	Littre.	“	Trans. Clin. Soc. Lond., vol. ix.
28	Id.	Amussat.	Died.	Lancet, vol. ii., 1877.
29	Maurice,	“	Recovered.	Ibid., vol. ii., 1883.
30	Nélaton,	Littre.	Died.	Canstatt's Jahresbericht, 1857.
31	Packard,	Amussat.	Recovered.	Am. Journ. Med. Sciences, 1874.
32	Phillip,	Not stated.	Died.	Tüngel, op. cit.
33	Pugliese,	Littre.	Recovered.	Lyon Médical, 1874.
34	Richet,	“	Died.	De l'Opportunité de l'Anus Artificiel, etc.
35	Savory,	Amussat.	Recovered.	Lancet, 1871.
36	Steele,	“	“	Med. Times and Gazette, 1872.
37	Thaden,	Fine.	“	Archiv f. klin. Chirurgie, Bd. iv.
38	Thomas,	“	“	Gazette des Hôpitaux, 1869.
39	Tiffany,	Amussat.	Died.	Am. Journ. Med. Sciences, N. S., vol. lxxiv.
40	Wheelhouse,	“	Undeterm'd.	Brit. Med. Journal, 1870.

TABLE XIV.—SHOWING THE RESULTS OF 4 CASES OF COLOTOMY FOR ULCERATION OF THE BOWEL.

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
1	Allingham,	Amussat.	Recovered.	St. Thomas's Hosp. Reports, N. S., vol. i.
2	Amussat,	“	Died.	Lond. Med. Gazette, 3d S., vol. ix.
3	Fenwick,	“	Recovered.	Canada Med. and Surg. Journal, 1877.
4	Heath,	“	“	Med. Times and Gazette, 1874.

TABLE XV.—SHOWING THE RESULTS OF 72 CASES OF COLOTOMY FOR STRICTURE OF THE BOWEL.

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
1	Allingham,	Amussat.	Recovered.	Schmidt's Jahrbucher, 1874.
2	Id.	“	“	St. Thomas's Hosp. Reports, N. S. vol. i.
3	Id.	“	“	Ibid.
4	Id.	“	“	Ibid.
5	Avery,	“	Died.	Trans. Path. Soc. Lond., vol. iii.
6	Bahnsen,	“	Recovered.	Virginia Med. Monthly, 1876.
7	Barwell,	“	Died.	Trans. Clin. Soc. Lond., vol. xii.
8	Benham,	Not stated.	Recovered.	Brit. Med. Journal, vol. ii., 1876.
9	Blaker,	Amussat.	“	Lancet, vol. i., 1881.
10	Briddon,	“	“	Medical Record, 1878.
11	Id.	“	Died.	Ibid.
12	Bridge,	“	Recovered.	Archives of Dermatology, vol. ii.
13	Bryant,	“	“	Med. Times and Gazette, 1872.
14	Id.	“	Died.	Lancet, vol. i., 1860.
15	Id.	“	Recovered.	Brit. and For. Med. Chir. Rev., 1869.
16	Id.	“	“	Lancet, vol. i., 1874.
17	Couper,	“	Died.	Brit. Med. Journal, 1869.
18	Critchett,	“	“	Lond. Hosp. Reports, vol. ii.
19	Crompton,	“	“	Tüngel, op. cit.
20	Curling,	“	Recovered.	Lond. Hosp. Reports, vol. iv.
21	Id.	“	Died.	Ibid.
22	Elder,	“	Recovered.	Lancet, vol. i., 1883.
23	Id.	“	“	Ibid.
24	Evans,	“	“	Med.-Chir. Trans., vol. xxviii.
25	Fenwick,	“	Died.	Canada Med. and Surg. Journal, 1877.
26	Field,	“	Recovered.	Med.-Chir. Trans., vol. xxxiii.
27	Foote,	“	“	Lancet, vol. ii., 1874.
28	Freer,	Littre.	Died.	Lond. Med. and Phys. Journal, 1821.
29	Heath,	Amussat.	Recovered.	Brit. Med. Journal, 1872.
30	Id.	“	“	Ibid.
31	Id.	“	“	Ibid.
32	Id.	“	Died.	Schmidt's Jahrbucher, 1874.
33	Henry,	“	“	Brit. and For. Medico-Chirurg. Review, 1856.
34	Hilton,	“	Recovered.	Guy's Hosp. Reports, 1868.
35	Id.	Callisen.	“	Med.-Chir. Trans., vol. xxxv.
36	Holmer,	Littre.	Died.	Nord. med. Arkiv, Bd. vi.
37	Id.	“	“	Ibid.
38	Holthouse,	Amussat.	“	Med. Times and Gazette, 1858.
39	Howe,	“	Recovered.	New York Med. Journal, vol. xxi.
40	Hulke,	“	Died.	Lancet, vol. ii., 1872.
41	Jessop,	“	Recovered.	Ibid.
42	Keyworth,	“	Died.	Med.-Chir. Trans., vol. xxxv.
43	Lane,	Littre.	“	Brit. Med. Journal, 1858.
44	Luke,	“	Recovered.	Med.-Chir. Trans., vol. xxxiv.
45	Martland,	“	“	Edinb. Med. and Surg. Journal, vol. xxiv.
46	Mason,	Amussat.	“	Am. Journ. Med. Sciences, N. S., vol. lxvi.
47	Id.	“	“	Ibid.
48	Id.	“	Died.	Ibid.
49	Id.	“	“	Ibid.
50	Maunder,	“	Recovered.	Med. Times and Gazette, 1869.
51	Id.	“	“	Ibid.
52	Id.	“	Died.	Ibid., 1872.
53	Id.	“	Recovered.	Ibid.
54	Nélaton,	Littre.	Died.	Canstatt's Jahresbericht, 1857.
55	Packard,	Amussat.	“	Personal communication.
56	Pearse,	“	Recovered.	Lancet, vol. ii., 1873.
57	Pennell,	“	“	Med.-Chir. Trans., vol. xxxiii.
58	Pring,	Littre.	“	Schmidt's Jahrbucher, 1834.
59	Id.	“	“	Lond. Med. and Phys. Journal, 1821.
60	Reeves,	Amussat.	“	Med. Times and Gazette, vol. i., 1878.
61	Sands,	“	“	New York Med. Journal, 1865.
62	Savory,	“	Died.	Lancet, 1871.

TABLE XV.—*Concluded.*

No.	Operator or Reporter.	Form of operation.	Result.	Reference.
63	Simon,	Amussat.	Died.	Tüngel, op. cit.
64	Smith,	"	Recovered.	Boston Med. and Surg. Journal, vol. cviii.
65	Solly,	"	"	Lancet, vol. i., 1856.
66	Id.	"	"	Ibid., 1857.
67	Teale,	"	Died.	Med.-Chir. Trans., vol. xxxv.
68	Thompson,	Not stated.	"	Lancet, vol. i., 1859.
69	Id.	Amussat.	"	Med. Times and Gazette, vol. i., 1877.
70	Trevor,	"	"	Lancet, vol. ii., 1867.
71	Verneuil,	Littre.	"	Med. Times and Gazette, 1869.
72	Weir,	Amussat.	"	New York Med. Journal, vol. xxi.

TABLE XVI.—SHOWING THE RESULTS OF 9 CASES OF COLOTOMY FOR VARIOUS LESIONS.

(*Condensed from Dr. W. R. Batt's Table.*)

No.	Operator or Reporter.	Nature of case.	Form of operation.	Result.	Reference.
1	Amussat,	Iliac phlegmon.	Amussat.	Recovered.	Gazette des Hôpitaux, 1842.
2	Druitt,	Obliteration of bowel.	"	Died.	Lancet, vol. i., 1860.
3	Hulke,	Contraction of bowel after dysentery.	"	"	Med. Times and Gazette, vol. i., 1879.
4	Kundsen,	Hernia and gangrene.	Not stated.	Recovered.	Van Erckelens, loc. cit.
5	Maisonneuve,	Hernia and gangrene.	"	"	Archives Gén. de Médecine, 4e S., t. vi.
6	Nicaise,	Intestinal cicatrix.	Littre.	Died.	Gazette Méd. de Paris, 1875.
7	Thaden,	Intussusception.	"	"	Archiv f. klin. Chirurgie, 1862.
8	Tüngel,	Volvulus.	"	Recovered.	Ibid., 1861.
9	Weber,	Hemorrhoids.	Amussat.	"	Personal communication.

An analysis of these tables shows that of the whole 351 cases, 133 ended fatally, a mortality in determined cases of 37.9 per cent. The most favorable cases are those of intestinal fistula, of which only 10 per cent. end in death, and the least favorable those of imperforate rectum, of which more than half (52.9 per cent.) prove fatal. As regards the form of operation, it may be said, in general terms, that more than one-third die after colotomy by Amussat's or Callisen's method,[1] and more than one-half when Littre's plan is adopted. These points may be conveniently seen in the annexed summaries:—

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[1] Callisen's differs from Amussat's operation merely in the fact that the external incision is longitudinal instead of transverse.

ANALYSIS OF 351 CASES OF COLOTOMY EMBRACED IN TABLES X.—XVI.

Nature of affection.	Cases.	Result not ascertained.	Recovered.	Died.	Mortality per cent. of terminated cases.
Cancer of bowel	154	1	104	49	32.0
Intestinal fistula	20	...	18	2	10.0
Imperforate rectum	52	1	24	27	52.9
"Obstruction of the bowel"	40	2	19	19	50.0
Ulceration of the bowel	4	...	3	1	25.0
Stricture of the bowel	72	...	41	31	43.1
Various lesions	9	...	5	4	44.4
Aggregates	351	4	214	133	37.9

Form of operation.	Cases.	Result not ascertained.	Recovered.	Died.	Mortality per cent. of terminated cases.
Amussat	244	2	164	78	32.2
Littre	82	1	38	43	53.1
Callisen	10	1	2	7	77.7
Fine	4	...	4	...	0.0
Not stated	11	...	6	5	45.4
Aggregates	351	4	214	133	37.9

ENTERECTOMY, or resection of a segment of the small intestine, has usually been performed in cases of gangrene of the bowel following strangulated hernia, or in those of fecal fistula; but it may also be properly performed, subsequent to laparotomy (when it is called *laparo-enterectomy*), in cases of gangrene, certain cases of intestinal stricture and tumor, occlusion of the bowel by inseparable adhesions, volvulus, and irreducible, chronic intussusception. It is, of course, a more dangerous operation than laparo-enterotomy; but, on the other hand, offers, as that does not, a prospect of perfect and permanent cure. The operations of enterectomy and laparo-enterectomy may each be done in two ways: (1) the diseased portion of bowel may be simply cut away, and the ends attached to the external wound so as to form an artificial anus; (2) after resecting the diseased segment, the ends may be approximated with sutures and the gut returned into the abdominal cavity. The latter plan is the proper one in cases of fecal fistula, and in some cases of obstruction very high up in the small intestine, as in the duodenum, where the establishment of an artificial anus would very much interfere with the patient's nutrition; but in all ordinary cases of intestinal obstruction, as in gangrene after strangulated hernia, it is safest at first to make an artificial anus, and on a subsequent occasion, if necessary, to attempt to restore the continuity of the intestine. In cases of hernia and fecal fistula, the operation is performed at the seat of disease; in other cases it is better, as a rule, to make the incision in the course of the linea alba, and endeavor to bring the affected bowel to the median line, where, after resection, its ends can be most conveniently fastened; but if this cannot be done, a second incision must be made directly over the obstructed part.

It is often of the greatest importance, in this operation, to prevent the extravasation of blood and fecal matter into the abdomen; hence, as soon as the diseased portion of bowel is exposed, it should be well drawn out, and the external wound either closed as far as possible, or filled with soft sponges so as to cut off all communication with the parts within. Several surgeons, including M. Rydygier, Mr. Treves, and Mr. Gibson, of Manchester, have devised ingenious clamps for temporarily compressing the gut, and thus preventing the escape of its contents. The section of the bowel is best made with scissors, a portion of healthy bowel being left between the cut and the clamp, so as to allow space for the adjustment of the sutures. A triangular piece of the mesentery should also be excised, the base of the triangle corresponding to the extent of the resected intestine, and the wound being closed with fine sutures. The clamps are then cautiously removed, first from the lower and afterwards from the upper end, and the parts are attached to the external wound by numerous stitches.

When an attempt is made to restore the continuity of the gut, either as a primary or secondary procedure, the clamps, carefully adjusted, are fastened together so as to approximate the cut ends of bowel, and these, having been freshened, if necessary, are then secured to each other by two rows of sutures, one bringing together the edges of mucous membrane, and buried in the tissues of the gut, and the other applied through the serous and muscular coats, as in Lembert's method.[1] Mr. Treves justly condemns Gussenbauer's suture as needlessly complicated. In order to facilitate the introduction of the stitches, cylinders of dough, decalcified bone, etc., have been introduced into the bowel, but are objectionable as exposing to the risk of at least temporary obstruction; if any guide is needed, a bag of thin India-rubber may be used, as suggested by Treves, being inflated after its introduction, and being allowed to collapse again, and withdrawn, before adjusting the last suture. The operation is completed by returning the sewed-up bowel into the abdomen, and closing the external wound.

Colectomy, a resection of a portion of the large intestine, is less often practised than enterectomy, and indeed can seldom be recommended except in certain cases of malignant stricture of the colon, or of fecal fistula, or what Mr. Morris calls "false anus," of this part.[2] In cases of this kind the place of incision is, of course, determined by that of the fistula, but under other circumstances colectomy is, as a rule, best effected through an incision in the lumbar region, as in lumbar colotomy, the bowel being drawn out and dealt with in the manner, and with the precautions, described in speaking of enterectomy. Nicolaysen has reported a successful case of colectomy performed *through the rectum.*

The *statistics* of these operations, *enterectomy* and *colectomy*, have been made a subject of special study by Madelung,[3] Rydygier,[4] Reichel,[5] and Makins.[6]

To the histories tabulated by these writers I have been able to add a number of others, and the following table contains references to 186 cases, a larger series than has yet been collected:—

[1] See Fig. 1123, Vol. V. p. 989, *supra.*

[2] See Vol. V. page 985, *supra.*

[3] Archiv f. klin. Chirurgie, Bd. xxvii. S. 277.

[4] Berliner klin. Wochenschrift, 18 Jahrgang, Nos. 41–43.

[5] Deutsche Zeitschrift f. Chirurgie, Bd. xix. S. 230.

[6] St. Thomas's Hosp. Reports, N. S., vol. xiii. p. 181.

TABLE XVII.—CASES OF RESECTION WITH OR WITHOUT SUTURE OF THE INTESTINE. (ENTERECTOMY AND COLECTOMY.)

No.	Operator.	Result.	Reference.
1	Albert,	Recovered.	Wien. med. Presse, 1881.
2	Aman,	Died.	Hygeia, Bd. xliii.
3	Ambrosi,	"	Indipendente, tomo xxxiii.
4	Amitesarove,	Recovered.	Union Méd., t. i. Carácas, 1881.
5	Banks,	"	Clinical Notes on Two Years' Surgical Work, etc., p. 96.
6	Bardeleben,	ied.	Deutsch. med. Wochenschrift, 1883.
7	Id.	"	Ibid.
8	Id.	"	Ibid.
9	Bardenheuer,	Recovered.	Die Drainirung der Peritoneal-höhle, 1881.
10	Id.	Died.	Ibid.
11	Barton,	"	British Med. Journal, Jan. 31, 1885.
12	Baudens,	"	Clinique des Plaies d'Armes à Feu, 1836.
13	Baum,	"	Centralblatt f. Chirurgie, 1879.
14	Id.	Recovered.	Berlin. klin. Wochenschrift, 1881.
15	Id.	Died.	Fortschr. d. Med., 1884.
16	Beebe,	Recovered.	Ill, Medical Record, Sept. 22, 1883.
17	Berger,	Died.	Bull. et Mém. de la Société de Chirurgie, 1880.
18	Bergmann,	Recovered.	Deutsch. med. Wochenschrift, 1883.
19	Billroth,	"	Wien. med. Wochenschrift, 1879.
20	Id.	"	Ibid.
21	Id.	"	Ibid., 1881.
22	Id.	"	Archiv f. klin. Chirurgie, Bd. xxiv.
23	Id.	"	Ibid., Bd. xxvii.
24	Id.	Died.	Wien. med. Wochenschrift, 1881.
25	Id.	"	Ibid.
26	Id.	Recovered.	Am. Journ. Med. Sciences, April, 1883.
27	Bouilly,	Died.	Bull. de la Société de Chirurgie, t. ix., 1883.
28	Boyer,	"	Traité de Chirurgie.
29	Bryant,	Recovered.	Lancet, May 13, 1882.
30	Bryk,	Died.	Przeglad Lekarski, 1881.
31	Id.	"	Ibid.
32	Byrd,	Recovered.	Medical Record, Aug. 5, 1882.
33	Id.	"	Ibid.
34	Calton,	"	Edinb. Med. and Surg. Journal, vol. xii.
35	Cherni,	Undeterm'd.	Index Medicus, Jan. 1881.
36	Cooper,	Died.	Anat. and Surg. Treatment of Hernia.
37	Id.	"	Ibid.
38	Credé,	Recovered.	Archiv f. klin. Chirurgie, Bd. xxvii.
39	Id.	"	Ibid.
40	Czerny,	"	rl. klin. Wochenschrift, 1880.
41	Id.	Died.	Ibid.
42	Id.	Recovered.	Ibid.
43	Dieffenbach,	"	Caspar's Wochenschrift, 1836.
44	Dittel,	"	Wiener med. Wochenschrift, 1878.
45	Duverger,	"	Mém. de l'Acad. Royale de Chirurgie, t. iii.
46	Esmarch,	Died.	Verhandl. d. Deutsch. Gesellsch. f. Chir., Bd. viii.
47	Feld,	Recovered.	Archiv f. klin. Chirurgie, Bd. xxx.
48	Fischer,	Died.	Deutsche Zeitschrift f. Chirurgie, Bd. xix.
49	Id.	Recovered.	Ibid.
50	Id.	Died.	Ibid.
51	Id.	Recovered.	Ibid.
52	Id.	Died.	Ibid.
53	Id.	Recovered.	Ibid.
54	Id.	"	Ibid.
55	Id.	"	Ibid.
56	Id.	Died.	Ibid.
57	Id.	"	Ibid.
58	Id.	"	Ibid.
59	Id.	Recovered.	Ibid.
60	Id.	"	Ibid.
61	Id.	"	Ibid.
62	Id.	Died.	Ibid.
63	Id.	"	Ibid.
64	Folker,	Recovered.	British Med. Journal, Feb. 7 and Aug. 15, 1885.

TABLE XVII.—*Continued.*

No.	Operator.	Result.	Reference.
65	Forbes,	Died.	Episcopal Hospital Records, 1885.
66	Fuller,	Recovered.	Medical Record, vol. xxii.
67	Id.	"	Ibid.
68	Gaston,	"	Med. and Surg. Hist. War of Rebellion, Second Surgical Volume.
69	Gentilhomme,	Undeterm'd.	Index Medicus, April, 1883.
70	Grindon,	Recovered.	St. Louis Courier of Medicine, 1884.
71	Gussenbauer,	"	Archiv f. klin. Chirurgie, Bd. xxvii.
72	Id.	"	Ibid.
73	Id.	Died.	Ibid.
74	Guyon,	"	Peyrot, De l'Intervention Chirurgicale dans l'Obstruction Intestinale, p. 84.
75	Hagedorn,	Recovered.	Verhandl. d. Deutsch. Gesellsch. f. Chirurgie, 1880.
76	Id.	"	Ibid.
77	Hardie,	"	Medical Chronicle, January, 1885.
78	Heusner,	Died.	Deutsch. med. Wochenschrift, 1880.
79	Hofmoker,	"	Wiener med. Presse.
80	Howse,	"	Med.-Chir. Trans., vol. lix.
81	Hueter,	"	Deutsch. Zeitschr. f. Chirurgie, Bd. ix.
82	Ill,	Recovered.	Medical Record, Sept. 22, 1883.
83	Id.	Died.	Ibid.
84	Jaffé,	Recovered.	Sammlung klinische Vorträge, No. 201.
85	Jessop,	"	Brit. Med. Journal, May 2, 1885.
86	Id.	"	Ibid.
87	Jobert,	Died.	Archives Gén. de Médecine, 1824.
88	Id.	"	Mém. de l'Acad. Royale de Méd., t. xii.
89	Jones,	"	British Med. Journal, Feb. 7, 1885.
90	Julliard,	Recovered.	Revue Méd. de la Suisse Rom., 1881.
91	Id.	"	Centralbl. f. Chirurgie, 1882.
92	Id.	"	Ibid.
93	Kinloch,	"	Am. Journ. Med. Sciences, vol. liv.
94	Kocher,	"	Bull. de la Soc. Méd. de la Suisse Rom., 1880.
95	Id.	Died.	Centralbl. f. Chirurgie, 1880.
96	Id.	Recovered.	Correspondenzbl. f. Schweizer Aerzte, 1878.
97	Koeberlé,	"	Gazette Hebdomadaire de Méd., 1881.
98	Korzenowski,	Died.	Berliner klin. Wochenschrift, 1881.
99	Kosinski,	"	Ibid.
100	Kraussold,	Recovered.	Sammlung klinische Vorträge, No. 91.
101	Id.	Died.	Ibid.
102	Kuester,	"	Verhandl. d. Deutsch. Gesellsch. f. Chirurgie, 1879.
103	Id.	"	Ibid.
104	Id.	"	Ibid.
105	Id.	"	Archiv f. klin. Chirurgie, Bd. xxvii.
106	Lammiman,	"	Lancet, Aug. 4, 1883.
107	Langenbeck,	"	Archiv f. klin. Chirurgie, Bd. xix.
108	Lavielle,	Recovered.	Journ. Gén. de Méd., de Chir. et de Phar., t. xliii.
109	Leisrink,	Died.	Archiv f. klin. Chirurgie, Bd. xxviii.
110	Lücke,	"	Deutsch. Zeitschr. f. Chirurgie, Bd. xii.
111	Ludvik,	Recovered.	Wiener med. Presse, 1880.
112	Luzenberg,	"	Gross, Medical News, May 3, 1884.
113	MacDonald,	"	Lancet, Feb. 9, 1884.
114	Madelung,	"	Archiv f. klin. Chirurgie, Bd. xxvii.
115	Id.	"	Berliner klin. Wochenschrift, 1881.
116	Maisonneuve,	Died.	Gazette des Hôpitaux, 1854.
117	Id.	"	Ibid.
118	Makins,	Recovered.	St. Thomas's Hosp. Reports, N. S., vol. xiii.
119	Marcy,	Died.	Ill, Medical Record, Sept. 22, 1883.
120	Marshall,	"	Lancet, May 6, 1882.
121	Martini,	Recovered.	Zeitschrift f. Heilkunde, 1880.
122	Maydl,	"	Wien. med. Presse, 1883.
123	Mensel,	"	Deutsch. med. Wochenschrift, 1883.
124	Id.	"	Ibid.
125	Moldenkow und Minin,	"	Centralbl. f. Chirurgie, 1881.
126	Morisani,	Died.	Rivista Internaz. di Med. et Chir., tomo i. pag. 146.
127	Nayler,	Recovered.	Cooper, op. cit.

TABLE XVII.—*Concluded.*

No.	Operator.	Result.	Reference.
128	Neuhauss,	Recovered.	Bull. et Mém. de la Soc. de Chirurgie, 1880.
129	Nicoladoni,	"	Wiener med. Blätter, 1879.
130	Nicolaysen,	"	Nord. med. Arkiv, Bd. xiv.
131	Novaro,	Died.	Centralbl. f. Chirurgie, 1882.
132	Obalinski,	"	Berliner klin. Wochenschrift, 1881.
133	Id.	"	Ibid.
134	Id.	"	Ibid.
135	Id.	"	Ibid.
136	Périer,	"	Gazette Médicale, 12 Fév. 1881.
137	Pirogoff,	Recovered.	Grundzüge der allgem. Kriegschirurgie, S. 578, 1864.
138	Pitcher,	"	Med. and Surg. Hist. War of Rebellion, Second Surg. Vol.
139	Pollard,	Died.	Lancet, March 17, 1883.
140	Porter,	Recovered.	Boston Med. and Surg. Journal, May 15, 1884.
141	Id.	"	Homans, ibid., July 30, 1885.
142	Prati,	Died.	Amer. Practitioner, Nov. 1883.
143	Ramdohr,	Recovered.	Hallerus, Disputat. Anatom., tom. vi.
144	Rehn,	"	Med. News, March 14, 1885.
145	Reybard,	"	Mémoire sur une Tumeur Cancéreuse, etc.
146	Richter,	"	Medical News, Sept. 30, 1882.
147	Robson,	Died.	Medical Record, August 8 and 22, 1885.
148	Rochelt,	"	Wiener med. Presse, Bd. xxiii.
149	Roggenbau,	Recovered.	Berliner klin. Wochenschr., 1881.
150	Roser,	Died.	Centralbl. f. Chirurgie, 1881.
151	Rydygier,	Recovered.	Deutschr. Zeitschr. f. Chirurgie, Bd. xv.
152	Id.	Died.	Berliner klin. Wochenschrift, 1881.
153	Salen,	Undeterm'd.	Index Medicus, March, 1883.
154	Schede,	Recovered.	Verhandl. d. Deutsch. Gesellsch. f. Chir., 1879.
155	Id.	Died.	Ibid.
156	Id.	Recovered.	Ibid.
157	Id.	Died.	Ibid., 1878.
158	Schinzinger,	"	Wiener med. Wochenschr., 1881.
159	Id.	Recovered.	Ibid.
160	Schmid,	"	Hallerus, Bibliotheca Chirurgica, tom. ii.
161	Schönborn,	Died.	Deutsch. Zeitschrift f. Chirurgie, Bd. viii.
162	Socin,	"	Centralbl. f. Chirurgie, 1881.
163	Sutton,	Recovered.	Med. News, June 16, 1883.
164	Tändler,	Died.	Archiv f. klin. Chirurgie, Bd. xxvii.
165	Tauber,	"	Verhandl. d. Deutsch. Gesellsch. f. Chirurgie, Bd. ix.
166	Thiersch,	Recovered.	Berliner klin. Wochenschrift, 1881.
167	Id.	Died.	Verhandl. d. Deutsch. Gesellsch. f. Chirurgie, 1878.
168	Id.	"	Beger, Berlin. klin. Wochenschr., 1882.
169	Trélat,	"	Peyrot, op. cit.
170	Id.	Undeterm'd.	Gazette Médicale, 12 Fév. 1881.
171	Id.	"	Ibid.
172	Treves,	Died.	Lancet, Dec. 16, 1882.
173	Truc,	Recovered.	Lyon Médicale, 1882.
174	Vermale,	"	Obs. et Remarques de Chirurgie Pratique, 1767.
175	Viertel,	"	Deutsch. med. Wochenschrift, 1877.
176	Volkmann,	"	Kompe, Aertzliches Intelligenzblatt, 1883.
177	Wahl,	Died.	St. Petersb. med. Wochenschrift, 1879.
178	Id.	"	British Med. Journal, May 26, 1883.
179	Weinlechner,	Recovered.	Wiener med. Wochenschrift, 1881.
180	Id.	Undeterm'd.	Aertzl. Ber. der k.-k. allg. Krankenh. zu Wien., 1883.
181	Weiss,	Died.	Berliner klin. Wochenschrift, 1881.
182	Id.	"	Ibid.
183	Wells,	Undeterm'd.	British Medical Journal, Nov. 15, 1884.
184	Whitehead,	Died.	Ibid., Jan. 24, 1885.
185	Wölfler,	"	Wiener med. Wochenschrift, 1881.
186	Id.	Recovered.	Medical Record, May 19, 1883.

Of the 186 cases embraced in the preceding table, 93 are reported as recoveries and 86 as deaths, the result in 7 not having been ascertained; the mortality of determined cases is therefore, according to these figures, 48 per cent. This corresponds very closely with the percentages given by Makins and Reichel, the former writer tabulating 94 cases with 44 deaths, or 46.8 per cent., and the latter 121 cases with 58 deaths, or 47.9 per cent. The mortality is least in cases of false anus (37.8 per cent., Reichel; 38.4 per cent., Makins), and increases progressively to 40 per cent. in cases of injury to the bowel, 50 per cent. in cases of intestinal cancer, 52 per cent. (51.8 per cent., Reichel; 52.7 per cent., Makins) in cases of gangrene following hernia, and 75 per cent. in cases of intestinal occlusion. Even, however, in the most favorable cases—those of false anus—the operation is a much graver one than that of Dupuytren[1] (use of the enterotome), 83 examples of which, collected by Heimann, gave 50 complete and 26 partial successes, and only 7 deaths (8.4 per cent.).

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[1] See Vol. V., page 983, *supra.*

INJURIES AND DISEASES OF THE RECTUM.

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Anatomy and Physiology of the Rectum.

The last portion of the intestinal canal, the rectum, measures from its commencement at the left sacro-iliac synchondrosis to its termination at the anus, from six to eight inches in the adult. The name *rectum* has but partial justification, and that only in comparison with the great bulk of the intestinal tract; for this tube is anything but straight, having antero-posteriorly two well-marked curves, an upper, which follows precisely the curve of the sacrum and coccyx, and a lower, which commences at the tip of the coccyx, with its convexity forwards, and terminates about an inch from it at the small orifice known as the anus.

Besides these antero-posterior curves, a lateral one, from left to right, is usually described, beginning at the left sacro-iliac synchondrosis, and terminating at the third sacral vertebra. But from observations in the post-mortem room I am inclined to think that no hard and fast line can be drawn about this lateral curve. The meso-rectum gives the first part of the rectum great play, and as often as not, on opening a body, what corresponds to the commencement of the rectum is found close to the right instead of the left synchondrosis. About an inch and a half from the orifice of the anus, which distance is occupied by the internal sphincter, a dilatation occurs in the lumen of the gut, and in those suffering from chronic constipation this may assume enormous dimensions. I have myself found an impaction of feces lodged in this part, the size of a fœtal head.

The *structure of the rectum* differs in some respects from that of the large intestine generally.

Muscular Coat.—This is much thicker than in other parts of the bowel, for in defecation the expulsion of feces is greatly dependent on its action. As throughout the remainder of the intestinal tract, it consists of two layers—an external longitudinal, and an internal circular. The former of these, however, is pretty evenly distributed around the gut, and is not collected into three bundles, as in the colon. On the anterior surface of the bowel the fibres are found lying thicker and closer than elsewhere. The termination of these longitudinal fibres is interesting. Some of them, according to Dr. Garson, pass from the rectum to the bladder, immediately beneath the peritoneum. The remainder are continued to the lower margin of the internal sphincter, where some, according to Dr. Horner, who wrote in 1826, turn under this margin, between it and the external sphincter, and then extend upwards for an inch or two in contact with the mucous membrane, into which they are finally inserted. I must confess that I have not succeeded in proving to my own satisfaction this terminal arrangement of fibres, although I have examined many rectums for that purpose. Other fibres are said to pass between the bundles of the external sphincter, and to be inserted into the subcutaneous connective tissue around the anus; while still a third set pass backwards towards the coccyx, into the anterior surface of which they are inserted by means of a very thin tendon. We now come to the circular fibres. Of these there is little to be said, except that, like the longitudinal, they are far better represented in the rectum than elsewhere throughout the intestinal tract. At the terminal inch and a half of the bowel they are collected in great numerical force, and constitute the internal sphincter. I have often observed how this muscle varies in different individuals, both in extent and power, while dilating it previous to operating on internal hemorrhoids. In some it readily yields after a moment's effort, while in others I have to use my whole strength for a considerable time. The explanation probably is, that, in the latter cases, the muscle has been subjected to frequent contractions in consequence of the presence of a fissure or an ulcer of the anus, which has produced an increase in its strength, and possibly in its bulk. A third sphincter has been described by O'Beirne, as situated high up, near the sigmoid flexure. Nélaton, too, has described a partial sphincter two and a half inches from the anal orifice. I must say that I myself do not believe in the existence of either the one or the other of these additional sphincters, except as an occasional, and, in my experience, an exceedingly rare, anatomical curiosity.

The submucous connective tissue of the rectum is abundant, especially at its lower part, where it forms the nidus in which the rectal vessels ramify after having made their way through the muscular coat, as will be described hereafter. Strong septa pass between the bundles of muscular fibres, which form a kind of framework for them, to the fibrous stroma of the fat surrounding the rectum.

The mucous membrane lining the rectum does not materially differ, as far as I am aware, from that found in the remainder of the large intestine; like that it consists of closely packed Lieberkühn's follicles, with here and there a solitary gland which is only a circumscribed nodule of lymphoid tissue. Immediately over the solitary glands, Lieberkühn's follicles are absent. The muscularis mucosa—or unstriped muscular layer of the mucous membrane proper—is said to be well developed around the anus, and to counteract any tendency, should such exist, to prolapsus. Certain marks and folds of the mucous membrane are interesting, and will now be examined. First, there is the white line around the anus which marks the junction of mucous membrane and skin, as also the linear interval between the internal and external sphincters. Next, the columnæ of the rectum, or the pillars of Glisson or of Morgagni. These, from six to eight in number, commence at the point of union of skin and mucous membrane, and extend about three-quarters of an inch or more up the bowel. They are permanent—that is, they are present even when the anus and lower part of the rectum are distended—and in each is found one of the parallel rectal arteries, branches of the superior hemorrhoidal, described by Quain. Little arches of mucous membrane, with their concavities upwards, unite the anal extremities of these pillars, and have been called "anal valves." They are often so indistinct as not to be recognizable. Lastly, I must just mention the so-called valves of mucous membrane described by Houston, in the year 1830, although I may at once say that I do not believe in their existence. He enumerates four, arranged in a spiral manner, the second, which is the largest, being on the anterior wall opposite the base of the bladder, and he ascribes to them the function of sustaining the fecal mass to avoid pressure on the sphincter, until the rectum is fully distended. Having already stated my disbelief in their very existence, I need not waste space in refuting the physiological functions ascribed to them, but will pass at once to the consideration of the muscles of the rectum and anus.

Muscles of the Rectum and Anus.—The *external sphincter* consists of voluntary fibres, which arise by a tendon from the tip of the coccyx, and are inserted into the central tendon of the perineum. It is elliptical in shape, and about half an inch in breadth. Its function is to close the anus under the influence of the will. Mr. Hilton, in his Lectures on Rest and Pain, has so admirably described what we occasionally owe this indomitable little sphincter, that I cannot refrain from quoting him:—

> The strength and endurance of the anal sphincters are well exemplified by their successful antagonism to the peristaltic action of the colon and rectum upon large quantities of fluid or solid feculent matter, constantly gravitating towards the anal aperture, guarded by the watchful sphincters. Who is there that has not felt this kind of competitive struggle, this intestinal warfare going on within himself, fearing the issue, and has not been thankful for the result, and full of gratitude for the enduring strength of the little indomitable sphincter, which has averted a possible catastrophe.

The nerve-supply of the external sphincter is derived from the hemorrhoidal branch of the internal pudic nerve, and from the fourth sacral.

The *internal sphincter* has already been described, in connection with the circular fibres of the rectum of which it is only an accentuation. Its nerve-supply is derived from Auerbach's plexus, and also from the hemorrhoidal branch of the internal pudic.

The *levator ani* is an irregularly quadrilateral muscle, which, with its fellow of the opposite side, forms a kind of inverted cone with two openings inferiorly for the transmission of the rectum and the urethra, in the male, the vagina of course in the female also passing through it. It arises from the posterior surface of the descending ramus of the pubis, sometimes from the articular cartilage, from the white line which marks the division of pelvic into obturator and recto-vesical fascia, from the internal surface of the spine of the ischium, and from the lesser sacro-ischiatic ligament. From this extensive origin most of the fibres pass down towards the median line, and are inserted as follows: The anterior fibres course down along the side of the prostate, beneath which they meet their fellows at the central tendon of the perineum; the middle fibres are inserted into the side of the rectum; and the remaining fibres pass between the rectum and coccyx into a median raphe, the posterior of these being inserted into the sides of the coccyx. It should be mentioned that a set of fibres belonging to the levator ani have been described as almost horizontal in direction, arising from the pubis and being inserted into the coccyx.

The action of the levator ani is likely enough to become a subject of dispute, as recently a new theory has been started, namely, that this muscle assists defecation by compressing the rectum at a point about two and a half inches from the anus—the point, in fact, at which the horizontal fibres are said to cross the rectum. I myself am not yet a convert to this novel view, and prefer to regard the levator ani, first, as an antagonist of the diaphragm and abdominal muscles when compressing the abdominal contents; secondly, as an antagonist of the sphincters in defecation by opening the anus. As this muscle when in action exerts pressure on the neck of the bladder through the fibres passing to the central tendon, thus preventing urine from entering the urethra, micturition and defecation cannot well occur simultaneously. After an operation for internal hemorrhoids, it is usually necessary to pass a catheter the first night, in order to empty the bladder. I am not quite clear in my own mind how far the levator ani is directly responsible for this, or whether the retention is due to nervous influences. The nerve supply of the levator ani is from the fourth sacral and from the internal pudic.

The *transversus perinei* arises from the inner surface of the descending ramus of the pubis, close to the ischial tuberosity, and is inserted into the central tendon of the perineum. Its action has been described by Cruveilhier as assisting that of the external sphincter in compressing the anus. It has, however, always appeared to me to be mainly concerned in steadying the central tendon while the other muscles inserted into it are in action. Its nerve comes from the internal pudic through the perineal nerve.

Vessels of the Rectum and Anus.—The blood supply of the rectum is derived from two sources, the inferior mesenteric and the internal iliac artery. The first terminates in the *superior hemorrhoidal artery*, which passes down behind the rectum between the two layers of meso-rectum, and soon divides into two branches, which in their turn break up into seven or eight—the parallel rectal arteries which are found in the pillars of Glisson already referred to. The internal iliac usually gives off the *middle hemorrohidal*, through the inferior vesical, and the *inferior hemorrhoidal* through the internal pudic artery. Both these arteries are small, and are distributed to the lower part of the rectum and anus only. The veins correspond to the arteries, that is to say, there are three sets—superior, middle, and inferior—which, according to my observation, communicate freely in a plexus around the lower part of the bowel, the hemorrhoidal plexus. The superior hemorrhoidal vein is, like the artery, single. It is the commencement of the inferior mesenteric, and so joins the portal system; like the other veins of this system, it is devoid of valves. Verneuil, who has devoted a great deal of time and labor to the elucidation of the anatomy of these veins, says that they commence at the upper border of the internal sphincter, and lie under the mucous membrane of the rectum. At a definite height of about four inches, they perforate abruptly the muscular coats of the bowel through "véritables boutonnières musculaires," and unite to form five or six large veins found in the meso-rectum; these then join the inferior mesenteric vein, as already explained. Verneuil is also of opinion that little or no anastomosis takes place between the superior and the other hemorrhoidal veins, and that, at least as far as this region is concerned, the portal and general systems are practically distinct. I have already said that I by no means participate in this view.

The *middle hemorrhoidal veins*, one on either side, join the internal iliac veins; they arise from the hemorrhoidal plexus, and, according to Duret, are formed by two venous trunks, one in front of and the other behind the rectum.

The *inferior or external hemorrhoidal veins* are also connected with the above-mentioned plexus, and empty themselves into the internal pudic veins.

Nerves.—The sensory nerves which supply the skin around the anus are the *inferior hemorrhoidal* and the *posterior superficial perineal*—branches of the internal pudic—and the posterior branches of the *lower sacral nerves*. The nerve supply of the muscles has already been referred to in the description of these. The *mesenteric and hypogastric plexuses* supply many branches to the rectum, the muscular coat of which is provided with *Auerbach's plexus*, an offshoot of that first mentioned. The external sphincter is maintained in a state of tonic contraction by a centre in the lumbar portion of the spinal cord. During defecation this centre is inhibited by the action of the will, by emotions, or by other nervous events (Foster.)

Lymphatics.—Those from the skin around the anus pass to the glands of the groin; those from the rectum proper communicate with the glands in the hollow of the sacrum and the lumbar glands. So that in fissure or ulcer of the anus, the inguinal glands, and in cancer the pelvic and lumbar glands, will be affected.

Relations of Rectum.—The relation of the peritoneum to the rectum is by far the most important, and I will therefore begin with its consideration. The question is, how far down the rectum does the peritoneum extend? how much of the rectum can be excised without running the risk of laying open the peritoneal cavity? I have myself removed five inches of bowel from a male, without even seeing the peritoneum. In a female patient on whom I operated, Douglas's pouch was only two inches from the anus. In another case, that of a male, three and a half inches of rectum were cut off, the peritoneal cavity was thereby opened, and a coil of intestine protruded. From these examples it will be seen that no hard and fast line can be drawn as to the distance down the rectum which the peritoneum extends. Still, bearing in mind the variations which have occurred in the practice of a single individual, three inches may be taken as a fair average when the bladder is fairly distended with urine; a little less if it be empty, a little more if it be fully distended. The upper portion of the rectum, which terminates at the third vertebra of the sacrum, is surrounded by peritoneum; it has, in fact, a meso-rectum, which allows it considerable play. Thus Mr. Davy, by means of his lever in the rectum, easily compresses the right common iliac artery. The other parts in relation with the rectum are, behind, the pyriformis muscle, sacral plexus of nerves, and branches of the internal iliac artery, and in front, in the male, the bladder and coils of small intestine; in the female, the uterus takes the place of the bladder. The middle portion of the rectum begins at the third vertebra of the sacrum, and ends at the tip of the coccyx. It has behind it the sacrum and coccyx, and in front, at its upper limit, the peritoneal fold of Douglas, and then the base of the bladder, vesiculæ seminales, and prostate gland. The lower portion has in front of it the membranous part of the urethra, separated by the triangular ligament on either side of the levator ani, and it is surrounded at its termination by the external sphincters.

Malformations of the Rectum and Anus.

As my personal experience of these errors in development has not been greater than that of any hospital surgeon not especially devoting himself to rectal surgery, I intend to treat this subject briefly, referring those among my readers who desire further information to Dr. Wm. Bodenhamer's exhaustive treatise on the "Etiology, Pathology, and Treatment of the Congenital Malformations of the Rectum and Anus."

The classification which I propose to adopt has, if no other merit, that of simplicity. I shall divide all these cases into four divisions, as follows:—

I. Those in which the anus is closed, the rectum being either partially or wholly deficient.

II. Those in which the anus exists in its normal condition, but opens into a *cul-de-sac*, the rectum being partially or wholly deficient.

III. Those in which a membranous septum, like a hymen, or a band of skin derived from the scrotum and fixed to the coccyx, stretches across the orifice—in the first case preventing, and in the second obstructing the outflow of meconium.

IV. Those in which the anus is absent, and in which the rectum opens into the bladder, urethra, or vagina, or in some other abnormal position.

In regard to the treatment to be adopted in cases of the first three divisions, there can be room for no two opinions: an outlet must be effected; obviously through the anus, if possible, but if not, through the sigmoid flexure in the left groin.

In those cases in which a membranous septum, or a band of skin, stretches across the orifice, the treatment is easy and successful. A crucial incision through the first obstruction, the removal of the second by means of a snip at either extremity, is all that is required. Not so, however, in the class of cases in which the rectum itself is more or less deficient. Here the surgical procedure is difficult, and, as a rule, not very successful.

In the new-born infant, the pelvic measurements are naturally very small: the antero-posterior, from the tip of the coccyx to the symphysis pubis, and the lateral, from one tuber ischii to the other, are each but little over an inch. When therefore it is considered that a dissection of an inch and a half or more, up the pelvis, may have to be undertaken before the blind extremity of the rectum is found, the advantages of adopting M. Verneuil's mode of procedure, namely, excising the coccyx, appear very great. Some surgeons recommend this step *after* a diligent search for the gut has been already made, but I am certain that this is a mistake. I think that in a case of this kind, in which life and death are in the scales, it is the operator's duty to give himself every chance from the beginning; and, always, of course, excepting those cases in which a bulging shows that the rectum is low down, removing the coccyx, although it be a mere nodule, increases the space in which to work in the right direction, that is, posteriorly.

If the surgeon has succeeded in finding the rectum, should he bring it down and attach it by sutures to or as near to the skin as possible? I am inclined to answer this question in the negative. If traction has to be put on the intestine to lower it, it is quite sure that the sutures will only tear or ulcerate through the wall of the gut, which will then certainly recede and fix itself at some higher point; whereas, if the intestine comes down readily without traction, I do not know that much is gained by putting in sutures, though something may be lost by preventing matter from being evacuated from between the sides of the intestine and the wound. The great tendency to contraction which exists in these cases must be overcome by most diligent dilatation, at first with the little finger, and afterwards with the forefinger, three times a day; after some months it may be sufficient to pass the finger only once a day, and perhaps, when a year has passed, once a week may suffice. Still, the most rigid watch must be kept, and at the slightest sign of contraction the times of dilatation must be redoubled.

Supposing that, after a most careful and prolonged search for the rectum, the surgeon fails to find it, what should be his next step? Some writers recommend waiting half a day, in the hope that the bowel may come down during straining, but I am of opinion that this chance is exceedingly small, and that the delay will considerably lessen the probability of success attending an operation in the groin.

The incision should be parallel with Poupart's ligament, and should begin outside of its centre. It should be not less than an inch and a half in length, and about a third or half an inch from the ligament. After dividing the skin and muscles, the fascia transversalis is reached, with the peritoneum beneath it. I doubt if it would be possible to insure dividing them separately; at any rate, nothing would be gained by the attempt, so that they may be simply cut through together cleanly on a director. The large intestine can be recognized by the absence, or at all events shortness, of mesentery, which conveys a feeling of fixity to the hand, and by the mesentery being attached to the left side of the intestine, as well as by the sacculated appearance of the latter. The other distinctive signs of the large intestine—its longitudinal bands and appendices epiploicæ—are generally too ill marked in the new-born child to be of diagnostic use. When the intestine has been found, it must be closely attached to the edges of the wound, peritoneal surface to peritoneal surface, with fine sutures, and then a very small opening made into it. Nélaton recommended an opening of less than a third of an inch.

When this operation of emergency has been successfully performed, should an attempt be made to establish a normal outlet by passing down a bougie through the wound in the intestine into the blind rectum, and directing it towards the perineal wound? I think not, for the following reason: A very thorough search has already been made from below, which has proved fruitless. Therefore there is strong reason to assume that the rectum terminates within the peritoneal cavity, and that its *cul-de-sac* is covered by peritoneum. At least so it has proved in several cases in which this procedure has been attempted, but has resulted in acute peritonitis and death.

In those cases, in the female, in which the rectum communicates with the vagina, and has no other outlet, the treatment indicated is as follows: If the bowels can be properly relieved through the opening, the surgeon may wait until the child is six months old, when it will be better able to bear the operation, which will also be rendered easier on account of the parts being larger. If, however, it is a question of urgency, through the opening being too small for the passage of meconium, a bent probe should be passed through the fistula and directed towards the perineum, and then cut down upon. The prognosis in these cases is favorable.

[If the rectum, in the male, open into the bladder or urethra, the best that can be done is to introduce a grooved director or small staff, and cut down upon this as in the operation of perineal section, thus forming a common cloaca for the escape of both fecal matter and urine. The opening must be kept patulous by subsequent dilatation. If the gut open on the surface of the body, at a distance from the normal position of the anus, it will usually be proper to decline an operation, and merely dilate the opening so as to prevent fecal accumulation.]

In conclusion, it must be mentioned that, although one would naturally suppose a speedy death to be the inevitable consequence of a rectum with no outlet, unrelieved by surgery, yet several cases are recorded in which periodic fecal vomiting has prevented such an issue.

[INJURIES OF THE RECTUM.

WOUNDS OF THE RECTUM.—Incised, lacerated, contused, punctured, and gunshot wounds are all met with in the rectum, but, provided that they are uncomplicated, usually heal without difficulty, and present no points calling for special notice. If the lesion involve the vagina or bladder, recto-vaginal or recto-vesical fistula may follow, and a plastic operation may ultimately be required. If the peritoneum be opened, in a deep rectal wound, peritonitis is, of course, apt to ensue, though not inevitable, and death may result under these circumstances. Hemorrhage from a rectal wound should be controlled by the application of ligatures, if the bleeding points can be seen, but if not, by pressure, which may be applied by means of Bushe's apparatus, an instrument resembling the colpeurynter—an India-rubber bag which can be introduced in a flaccid state, and afterwards distended with air or iced water—or, perhaps even more securely, by packing the gut around a tube or English catheter provided with an apron, as is done with the perineal wound after the operation of lithotomy. A remarkable case is recorded by Dr. Otis,[1] in which a distinguished officer, conducting a retreat under a heavy fire from the enemy, was killed by a ball entering his anus as he leaned forward over his horse's neck; no external wound was perceptible, and the nature of the lesion was not recognized until, when the body was embalmed, the ball was found lodged in the patient's lung.

Foreign Bodies in the Rectum.—These may have been directly introduced into the rectum through the anus, or through a wound, or may have descended from a higher point, having been swallowed, or, as in the case of gall-stones, having originated in another part of the patient's body. The variety of substances which have been found in patients' rectums, having been introduced either by themselves or by others, is very great,[2] embracing such diverse substances as pebbles, slate-pencils, diamonds, bottles, beer-glasses, forks, files, snails, and a pig's tail.[3] The *symptoms* caused by foreign bodies in the rectum are those of local irritation, often attended by great pain, with constipation, sometimes ending in complete obstruction. Peritonitis may ensue. The *treatment* consists in extraction, by such means as may be suggested by the requirements of the particular case and the inventive faculty of the surgeon. Anæsthesia is usually required, and advantage may be derived from thorough dilatation of the sphincter. If necessary, Verneuil's operation of linear rectotomy may be performed, as in cases recorded by Raffy and Turgis. Anodynes should be given afterwards in the form of suppository. Prompt treatment is essential in these cases, as the foreign body, if allowed to remain, may perforate the rectum, causing fistula; may ulcerate its way into the bladder, vagina, or peritoneum; or may slip up into the sigmoid flexure or descending colon, from which it could only be removed by a more dangerous operation.]

Fistula in Ano.

Fistula is the most common rectal disease affecting the adult, certainly in hospital practice, and probably in private practice too. Men are more subject to it than women.

This disease is most frequently met with during middle age, but it is by no means restricted to that period of life. I have often operated upon infants in arms, and upon men from seventy to eighty years of age.

Causes of Fistula in Ano.—The causes of fistula, or of abscess ending in fistula, are: Injuries to the anus; injury to the mucous membrane of the bowel by very costive motions, by straining at stool, or by foreign bodies swallowed (fishbones and the bones of rabbits are occasionally found in rectal abscesses); exposure to wet and cold, and particularly sitting upon damp seats after exercise, when the parts are hot and perspiring. I have traced many cases of rectal abscess to sitting on the outside of an omnibus, shortly after active exertion. Predisposing causes are the scrofulous diathesis and certain depraved conditions of the blood, such as frequently give rise to boils or carbuncles. Here I would observe that sudden and deep-seated suppuration is often found to occur after severe itching in the part, with only slight erythematous redness on the surface.

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[1] Medical and Surgical History, etc., Second Surgical Volume, p. 319.

[2] See Poulet's curious Treatise on Foreign Bodies in Surgical Practice, vol. i. pp. 217 *et seq.* New York, 1880.

[3] See Marchettis's case, Vol. V., page 994, *supra.*

Fistula in children almost always results from the presence of worms, or from injury to the anal region.

Course of Fistula in Ano.—Fistula, in the majority of cases, commences by the formation of an abscess immediately beneath the skin, just outside of the anus; it is generally said to commence in the ischio-rectal fossa, but I am certain that this is the rarer situation. It may also begin by ulceration of the mucous membrane of the rectum, as is seen in phthisical patients; when it arises in this manner fecal matter collects in the connective tissue, and thus an abscess forms and opens on the outside. Lastly, an abscess may form in the submucous connective tissue of the rectum, and then burst into the bowel.

This is its ordinary termination, but it may insidiously undermine the rectum in any direction, and I am convinced that the more serious forms of fistula not uncommonly originate in this manner.

Rectal abscess may arise rapidly, when there will be redness, tenderness, and often very acute pain, with constitutional disturbance; or it may be months in formation, and be perfectly painless even on manipulation, the only evidence of the abscess being a flat, boggy, crepitating enlargement which can be felt at the side of the anus. This form of abscess is the most dangerous, as it is apt to be neglected; it has little tendency to open spontaneously, and it results in a burrowing up by the side of the rectum to some distance, as well as under the skin towards the perineum, or buttock, or both. I think, on the whole, by far the most usual course is for the abscess to form rapidly, with great pain, and if not interfered with to burst externally; the patient then becomes suddenly easy, and fancies that his trouble is over. The cavity of the abscess seldom entirely closes, but sooner or later it contracts, leaving a weeping sinus with a pouting, papillary aperture, which may be situated near or far from the anus. It is not often that one sees a rectal abscess very early; either the patient is not aware of the importance of attending to the early symptoms, or he temporizes, using fomentations or poultices; or even when seen by the surgeon, the proper treatment is not always promptly adopted. I have seen large abscesses painted with iodine, in the hope of obtaining absorption. It is well to remember that, as soon as pus is formed, there is only one method of treatment to be for a moment considered, and that is *incision*. It is certainly less damaging to cut into an inflamed swelling near the anus without finding pus, than to let a day pass over after suppuration has commenced; the longer the abscess is left unopened, the greater is the danger of the formation of lateral sinuses. Before any pus exists, rest, warm fomentations, and leeches may cut short the attack, but such a result is very rare. Very small abscesses can be well and easily opened in the following way: The patient being placed on the side in which the swelling exists, the surgeon passes the forefinger of the left hand, well anointed, into the bowel, and then places the thumb of the same hand below the swelling, on the skin. Now making outward pressure with the finger in the bowel, and thus rendering the swelling quite tense and defined, it being in fact taken between the finger and thumb, a curved bistoury is to be thrust well into the abscess, in a direction parallel to the long axis of the bowel, and made to cut its way out towards the anus; it is well to make a thoroughly free incision, commencing at the outermost part of the swelling. If the part be thoroughly frozen by the ether-spray, this operation is rendered painless.

The method of operating above described is, however, by no means suitable to a severe or deep-seated abscess; but I can safely say that, if a patient suffering from this latter form will allow the surgeon to act in the proper way, it will be almost certain that no fistula will result. The following is the method which I adopt. The patient must take an anæsthetic, as the operation is very painful. I first lay open the abscess outside of the anus, from end to end, and from behind forwards, that is, in the direction from the coccyx to the perineum. I then introduce my forefinger into the abscess and break down any secondary cavities or loculi, carrying my finger up the side of the rectum as far as the abscess goes, probably under the sphincter muscles, so that only one large sac remains; should there be burrowing outwards, I make an incision deeply into the buttock, at right angles to the first. I then syringe out the cavity, and carefully fill it with wool soaked in carbolized oil, one part to twenty; this I leave in for a day or two, then take it out and examine the cavity, and dress the part again in the same manner, but in addition I now use, if I think it necessary, one or more drainage-tubes. In a remarkably short time these patients recover; the sphincters have not been divided, and the patient therefore escapes the risk of incontinence of feces or flatus, which sometimes occurs when both the sphincters are deeply incised. I could cite numbers of cases of very unfavorable aspect, and in old persons, that have done quite well, when treated as I have described. To give the patient the best possible chance of recovery, he should be kept on the sofa, if not in bed. I always think it advisable to clear out the bowels once, and then to confine them by an astringent dose of opium for three days; entire rest is thus secured to the parts, and every opportunity is given for the cavity of the abscess to fill up. After a time the carbolized oil should be discarded, and lotions used containing sulphate of zinc or copper, or friar's balsam, which last does great good. The surgeon should never stuff an abscess, but put wool in very lightly, and use drainage tubes, of which those of India-rubber are the best.

The questions naturally arise, why do these abscesses usually fail to close up? Why do they form sinuses? There are doubtless several reasons, but the following may be sufficient: The constant motion of the parts, caused by action of the bowels and by movement of the sphincters, almost at every breath, and the presence of much loose areolar tissue and fat. The vessels also, near the rectum, are not well supported, and the veins have no valves; there is therefore a tendency to stasis, and this is inimical to rapid granulation. We know that abscesses are always apt to degenerate into sinuses when situated in any lax areolar tissue, as in the axilla, neck, or groin.

After an abscess has long existed, the discharge loses its purulent character and becomes watery; the cavity gradually contracts, and at last only a sinus, very often formed of dense tissue, remains. If now a probe be passed very tenderly into this sinus, allowing it to follow its own course, and after this is done, the finger be placed in the rectum, it will probably be found that the probe has traversed the sinus and passed through an internal opening, and that it can be felt in the bowel. In this case there would be a typical, simple, *complete fistula;* and this is by far the most common variety, very few fistulæ that have existed for more than three months being without an internal opening.

Besides this common form there are two other descriptions of fistula, viz., the blind external fistula and the blind internal fistula. In the *blind external fistula* there is an external opening, and it is therefore called an *external* fistula, but no internal opening, and hence a *blind external fistula.* In the other variety there is an internal opening, and consequently it is an *internal* fistula, but there is no external opening, wherefore it must be called a *blind internal fistula.* The blind internal form of fistula results usually from some injury to, or ulceration of, the lining membrane of the rectum, or abscess in the connective tissue beneath the mucous membrane, and it is most commonly found in consumptive patients.

Now, these terms "complete," "blind external," and "blind internal" are useful, but surgically they are of little moment; there is, however, an important division of fistulæ as regards both patient and surgeon, and that is into *anal* fistulæ and *pelvic* or *rectal* fistulæ.

An *anal fistula* is one which commences in the skin a few lines from the margin of the anus, opens just inside the orifice, passes at most under a few fibres of the external sphincter, and is trivial and can be rapidly and safely cured. By *pelvic or rectal fistula* I mean a fistula which, commencing probably by an abscess in the ischio-rectal fossa, passes underneath both sphincter muscles, and opens possibly high up in the bowel, indeed in the pelvis. This is the fistula which is dangerous to the patient, and it will call forth all the knowledge and experience of the surgeon to bring it to a successful issue.

A patient with fistula should be examined in the following manner: He should be placed upon a hard couch, on the side upon which the disease is supposed to be situated, the buttocks being brought close to the edge of the couch, and the knees drawn up. The anus and surrounding parts should be carefully inspected to detect any visible malady. The orifice of a sinus may be seen, or some discoloration of the skin may show the site of the disease; then, feeling gently all around the anus with the forefinger, the surgeon will often, by the induration, detect the course and position of the sinus, which feels like a pipe or piece of wire beneath the skin. Having satisfied himself in these respects, he passes the probe into the external aperture, holding it with a very light hand, and letting it almost find its own way. In many cases, as I have before said, it will pass right into the bowel; when the probe has been passed as far as it will go without using any force, the surgeon introduces the forefinger of the left or right hand into the rectum, and feels for the internal opening of the fistula, if the probe has not passed through it; having found it, he can with the other hand guide the probe towards it. The internal opening is usually situated just within the anus, in the depression which exists between the external and internal sphincters. I think that the reason that the internal opening is situated so often in this position, is because when the abscess forms, as in most cases it does, just outside of the anus, it does not burrow deeply, but passes close under the external sphincter; it thus is prevented from ascending higher up the bowel by the thick band of the internal sphincter, and consequently is turned inwards, and makes its way through the lax areolar tissue, in the space between the two muscles. When the abscess really commences in the ischio-rectal fossa, it burrows deeply, and then most usually passes beneath the internal sphincter, and opens, if at all, high up in the rectum.

Occasionally more than one internal opening exists, and I have many times seen what the late Mr. Syme declared could not occur—viz., two internal openings in the same patient at the same time. It is all-important that this internal aperture be felt with the finger (so that in operating it may be included in the incision), for not infrequently, from the tortuous nature of the fistula, the probe cannot readily be got through it. This is markedly the case in the horse-shoe form of fistula, which is not uncommon. The sinus here runs around, generally dorsally, from one side of the anus to the other, so that the external and internal openings are placed on opposite sides of the bowel. This variety, if not properly diagnosed, is rarely cured by one operation, the sinus being laid open on one side of the bowel, and left untouched on the other. This mistake may generally be avoided by careful examination with the finger externally, as a hardness can be felt on *both* sides of the anus; the patient will also sometimes give assistance by saying that he has felt something like a "piece of wire" on both sides of the bowel.

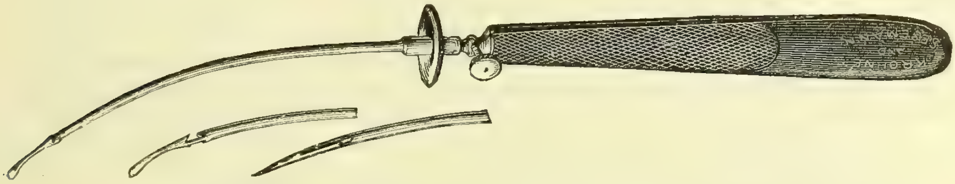
When the surgeon passes his finger into the bowel to search for the internal opening, he should never forget to carry it higher up, to see if the rectum be otherwise healthy; he may find stricture, ulceration, or malignant disease coexistent. Without this precaution these conditions may be overlooked.

Fistula may exist for years without causing much pain or inconvenience to the patient. I have met with many persons who had had rectal sinuses for ten years and upwards, and had never had anything done beyond the occasional passing of a probe when the external aperture had got blocked up, and when pain had been caused by the formation and retention of matter. When the tissues around the sinus become very dense, there may be for a long period an arrest of burrowing, but an attack of inflammation set up at any time will cause a fresh abscess. I am often anxiously asked by sufferers if a fistula can be cured without an operation. To this I reply, that I have seen fistulæ of all kinds get well without treatment, but that these occurrences are quite exceptions to the rule, and should not be depended upon; still, if the fistula be simple, and the patient be unwilling to submit to any operation, certain methods may fairly be tried. For the last few years I have been successful on many occasions in curing blind external, and even complete, fistulæ, by means of carbolic acid and drainage-tubes. This mode of treatment offers, in my opinion, the best chance for the patient. I first dilate the outer opening of the fistula for a few days with a small portion of sea-tangle or sponge-tent. When the opening is large enough, I clean out the sinus well, and then rapidly run down to the end of it a small piece of wool saturated in strong carbolic acid, with ten per cent. of water. I mount this wool upon a stiff piece of wire set in a handle, and just roughened at the free end; I then withdraw the wire and put in a drainage-tube, just large enough to fill the sinus, and keep it in; the interior of the sinus is, by the acid, induced to granulate, and, if successful, it will be found, almost day by day, that a shorter drainage-tube will be required until the whole sinus is filled up. It may be necessary to apply the acid more than once, and to use other stimulants, such as friar's balsam, solutions of sulphate of copper or nitrate of silver, etc. I have succeeded usually in some bad cases by scraping the walls of the sinus with a small curette of steel. I do not advise *injecting* the sinus; wool on a probe is a much better mode of medicating. Care should always be taken to keep the external opening well dilated. A perforated ivory collar-stud answers admirably in effecting this, the small hole allowing pus to dribble through. One practical point I would mention. The further the external opening is from the sphincter, the more likelihood is there that a sinus may heal. It is very important in these cases not to do any harm. The surgeon should always enjoin rest after a strong application, and watch that not too much inflammation be set up. It must be remembered that most of the so-called spontaneous cures are illusory, and that the disease returns in time, and the same may be said even of those in which treatment, short of division, has seemed effectual. In my opinion there is nothing equal to the division of the fistula, and getting it to fill up soundly from the bottom.

Whilst describing the treatment of fistula without cutting, I must refer to the use of the elastic ligature, so valuable in cases in which the knife is contra-indicated. The advantages of the ligature are the following: There is little or no pain, during or after its use, and there is no bleeding—a manifest advantage in dealing with patients whose tissues bleed copiously on incision.

In phthisical patients it is, in my opinion, the best means of dividing a sinus. In very deep, bad fistulæ, the elastic ligature is most valuable as an auxiliary to the knife. In sinuses running high up the bowel, where large vessels are inevitably met with, I use the ligature in preference to the knife, as I by this means often avoid dangerous hemorrhage. The objection to the general use of the ligature is that it is impossible, in many instances, to be absolutely sure that only *one* sinus exists. If there are lateral sinuses, or a sinus burrowing beneath or higher up the rectum than the main trunk through which the ligature is passed, the patient will not get well with one operation. In these complicated cases, the knife alone, or conjoined with the ligature, is the trustworthy remedy. I have for a long time now used only solid India-rubber, so strong that I cannot break it; and I put it on as tightly as I can, and fasten it by means of a small pewter clip pressed together by strong forceps. The ligature cuts through in about six days. I have devised an instrument (Fig. 1185) for passing the India-rubber through a fistula, which renders this generally tedious process easy and expeditious.

Fig. 1185.



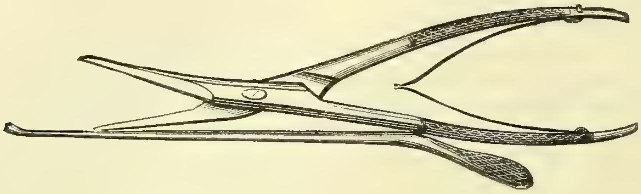
Instrument for drawing India-rubber through fistula from within outwards.

And now we come to the consideration of cutting operations for fistula. First of all, the patient's bowels must have been well cleared out; a purge three days before the operation, and again the night before, and an injection in the morning, will effect this.

The patient should be placed on a hard mattress, *on the side in which the fistula exists*, the buttocks being brought quite to the edge, and the knees well drawn up to the abdomen. The surgeon now takes a Brodie's probe-director made of steel, with a *small* probe-point; oils it and passes it into the external opening, through the sinus and the internal opening, if possible; then inserts his finger into the rectum, and on feeling the point of the director in the bowel, if the patient be not anæsthetized, tells him to strain down; he will thus be able, without difficulty, to turn the point of the instrument out of the anus. This done, the tissues forming a bridge over the director are to be divided with a curved bistoury. If the fistula be deep, running beneath the sphincters, it will not be possible to get the point of the probe out at the anus, even if the patient be anæsthetized; in such a case the surgeon must pass the director well through the sinus, then insert his left forefinger into the rectum, steady the director, and run a straight knife along the groove, cutting carefully towards the bowel until the parts are severed. To inexpert surgeons I recommend my deeply-grooved director and scissors (Fig. 1186); I may add that gentle dilatation of the sphincters under these difficulties gives the surgeon an immense advantage of which I now constantly avail myself.

If there be no internal opening, there will almost always be found some part where only mucous membrane intervenes between the point of the probe and the finger. At this spot, the director should be worked through, and the point brought down as before. When the fistula has been divided from the external to the internal opening, search is made higher with the probe for any sinus running up beyond the internal opening; if such exists, it must be laid open. Search is next made for lateral sinuses extending from the outer opening; also for any burrowing outwards beyond the same point. A fistulous orifice is often not at either end of the sinus, but somewhere in its course. The part should be carefully examined to see if there is a secondary sinus running from and beneath the main track. Frequently, in fact nearly always, in old-standing cases, the deeper sinus does exist, and unless it be incised with the rest, the patient will not get well.

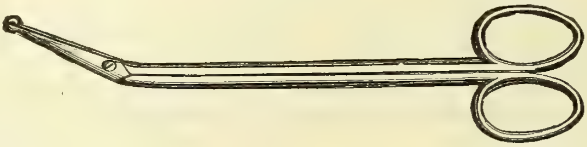
Fig. 1186.



Spring-scissors with probe-point in grooved director.

When all the sinuses are slit up, the surgeon with a pair of scissors (Fig. 1187) takes off a portion of the overlapping edges of skin; they are often thin and livid, having very little vitality. If not removed, they will fall down into the wound and materially retard the healing process. I have frequently induced healing in a fistulous track which had been only laid open, by paring off the edges of the skin which were undermined. In old-standing cases, where there is much induration, it is very good practice to draw a straight knife through the dense track of the fistula, and outwards beyond the external opening; it is wonderful how rapidly quite cartilaginous hardness passes away after this has been done. This incision was practised by the late Mr. Salmon, and is called his "back cut." Having completed the operation, the surgeon takes some absorbent cotton-wool, and with a probe packs it well into the bottom of the wound, packing it into every part, and being the more particular about this if the incisions have been extensive, or pass high up the bowel, or if the parts are very dense and gristly, and especially in cases operated on for the second time. Of course, if a large vessel is seen spirting, it is secured either by a ligature or by torsion before packing. The last step is to place a good firm pad between the buttocks, over the wounds, and a **T** bandage to exert pressure on it.

Fig. 1187.



Scissors for removing overlapping edges of skin in operation for fistula.

The most painful form of fistula, but at the same time fortunately the most uncommon, is the blind internal fistula. I have seen many cases where the aperture was one third of an inch in diameter. The feces, when liquid, pass into the sinus and create great suffering, a burning pain often lasting all day after the bowels have acted.

In operating upon a blind internal fistula, if the surgeon can feel by the hardness externally the site of the abscess, he may plunge his knife into it, and thus make a complete fistula through which of course he passes his director. If he cannot feel any hardness or see any discoloration to guide him to the situation of the sac of the abscess, the best way of proceeding is to bend a silver probe-director into the form of a hook, and then hook this into the internal aperture, and bring the point down close under the skin; he then cuts upon it, thrusts it through, and completes the operation.

In operating upon women suffering from fistula (especially when the sinus is near the perineum), I cut as little as possible, for anything like too free incisions are apt to end in incontinence of feces, or, at all events, in such partial loss of power in the sphincter as to prevent the patient retaining flatus, a result which I need scarcely say is a most disagreeable one. Even in males, incontinence of wind and liquid feces almost always results from cutting the muscles, and principally the internal sphincter, in more than one place. It should be made a rule to divide the sphincters at *right angles* to the direction of their fibres. If the muscles are divided at all obliquely, good union is never obtained, and even in comparatively slight cases incontinence may follow.

The method which I have adopted in cases of incontinence of flatus and liquid feces, is the use of Paquelin's thermo-cautery. Its judicious employment will stimulate the muscular fibres and cause them to contract, and by diminishing the circumference of the anus induce action of the fibres which are left. After an operation for fistula, the bowels should be confined for three days; a mild purge must then be administered, and full diet allowed. The wool usually comes out when the bowels act; if not, I gently remove it.

As a matter of fact I generally remove a portion of the wool the day after the operation, leaving only some at the bottom of the wound. If the whole plug is left in, the patient will probably be very uncomfortable, as he cannot easily get rid of wind, and the danger of primary hemorrhage being over in twenty-four hours, there is nothing gained by retaining a mass of wool in the bowel.

Very little dressing is required in the after-treatment of fistula; in fact, it is better to do *too little* than *too much*. The wound should be gently cleansed every day by allowing some weak Condy's solution or carbolic lotion (1 in 60) to flow over it, then tenderly dried with cotton-wool, and lastly a little wool soaked in olive oil should very gently be laid in the wound. Only when the wound is sluggish do I prescribe lotions; then, according to circumstances, blackwash, carbolic acid, sulphate of zinc or copper, tartrate of iron, or friar's balsam, may be advantageous. Iodoform, finely powdered or in ointment, I have found to be an excellent application. Although the surgeon should not interfere with nature's work, he must be always on the watch during the healing process for any burrowing or formation of fresh sinuses.

Whenever the discharge from a wound is more than its extent of surface seems to warrant, the surgeon may be sure that burrowing has commenced, and should search diligently for the sinus at once, for the longer it is left the larger and deeper it will get. Sometimes it is under the edges of the wound that it commences; at other times, at the end of the wound internally or externally; and occasionally it seems to dive down from the base of the main fistula. Such a sinus should be laid open at once. The patient, too, should always be encouraged to report immediately any pain in or near the healing fistula; often he will be the first to discover, by the existence of some unpleasant sensation, the commencement of a small abscess or sinus, and will be able also to indicate its situation.

It is important that the recumbent position should be kept for some time, but not necessarily in bed. After the first week or ten days subsequent to the operation I usually allow my patients to recline upon the sofa for the greater part of the day.

Never, if it can be avoided, should a fistula be operated upon that is from any cause acutely inflamed. While inflammation is going on, fresh sinuses are likely to form, the areolar tissue breaking down very readily; if an operation is performed under these conditions, failure is almost certain to ensue. All that should be done is to make a free dependent opening, and wait till the sac of the abscess contracts before laying open the resulting fistula with its offshoots.

The subject of *fistula in conjunction with phthisis*, which I have treated of very fully in my book on Diseases of the Rectum, I can only just advert to here, on account of want of space. From my cases I find that 16 per cent. of patients with anal fistulæ have had well-marked phthisis either active or latent. Fistulæ in persons of a phthisical tendency have the following peculiarities: They have a disposition to undermine the skin and mucous membrane with remarkable rapidity, but not to burrow deeply. The internal aperture is almost always large and open; on passing the finger into the bowel the opening can be felt most distinctly, often a third of an inch in diameter. The external opening is also frequently large and ragged, not round; it is irregular in form, and surrounded by livid flaps of skin; when the probe is passed into this aperture, it can be swept around over an area of more than an inch, and not infrequently the skin is so thin that the probe can be seen beneath. The discharge is thin, watery, and curdy, very rarely really purulent. The sphincter muscles are almost always very weak. When the surgeon introduces his finger into the bowel, he is hardly sensible of any resistance being offered. It is common to observe in these patients much longish, soft, silky-looking hair around the anus.

When a case of this kind comes to me, I am never in a hurry to operate. I like to watch the patient for a little while, and observe whether the lung mischief is advancing, and also find out if the cough is constant. I wait, if I can, for genial weather when the patient need not be confined to a close room. As for the operation, it must be thorough, but as *little interference as possible with the sphincter muscles, especially the internal*, should be made. After the operation the patient should not be confined to bed, but should be allowed to lie for hours on a mattress in a bedroom facing south or west, well covered up on a couch, by the open window. He should not be purged after the operation, but his bowels should be opened by diet and mild laxatives. If his bowels act once in three days, it is usually quite sufficient. For my own part, I do not think that there are any clinical facts tending to show that the operation for fistula in phthisical patients renders the lung affection worse, or makes it more rapidly progressive. Except in the case of *rapidly advancing* phthisis, if the operation be performed discreetly, at the right time of year, and with favorable surroundings, the patient does well, and will be benefited, not damaged, by the cure of his rectal malady.

Fissure and Painful Irritable Ulcer of the Rectum.

These are found more frequently in women than in men, although not rare in the latter. I have seen fissure in a baby in arms, and in an old woman of eighty, who was also suffering from impaction of feces.

By far the most usual seat of fissure is dorsal or nearly dorsal. It may be brought about by an injury or tearing of the delicate mucous membrane at the verge of the anus, such as may be caused by straining, or by the passage of very dry, hard motions; sometimes it follows severe diarrhœa; it is frequently the sequel of a confinement, or the accompaniment, and occasional result, of polypus. Syphilis is the origin of many fissures.

In fissure the pain during action of the bowels is more or less acute; some describe it as like tearing open a wound, and doubtless it is of a very excruciating character. I have known patients who for hours could not bear to stir from one position, the least movement causing an exacerbation of the pain. This agony induces the sufferer to postpone relieving the bowels as long as possible, the result being that the motion becomes desiccated and hardened, and inflicts more grievous pain when at last it has to be discharged. After an action of the bowels, the pain may in a short time entirely cease, and not return at all until another evacuation takes place; but often it continues very severe, and of a burning character, or it is of a dull heavy kind and accompanied by throbbing, lasting for hours, sometimes even all day, so that the patient is obliged to lie down, and is utterly incapable of attending to any business. In some instances the pain does not set in until a quarter or half an hour after the bowels have acted.

In children and young persons, unless a polypus complicates the fissure, I think it is almost always curable without operation. In children suffering from hereditary syphilis, numerous small cracks around the anus are common, and they cause much pain. Mercurial applications and extreme cleanliness soon cure them, but they will return from time to time unless antisyphilitic medicines be taken for a lengthened period.

Fissure, although really so simple a matter, and its cure generally so easy, wears out the patient's health and strength in a remarkable manner, the constant pain and irritation to the nervous system being more than most persons can bear. What under these circumstances is very extraordinary, is the length of time that people go on enduring the malady without having anything done for it. It is common for fissures to heal for a time, and then break out again, so that patients are apt to think that a perfect cure will presently result, and therefore defer proper treatment.

The usual position on the right side is the best for making an examination. The patient raises the upper buttock with the hand, and the surgeon then with forefinger and thumb gently opens the anus, telling the patient to strain down; at the same moment he will thus be able to see just within the orifice an elongated ulcer, shaped like a split grain of barley; its floor may be very red and inflamed, or, if the ulcer be of long standing, of a grayish color, with edges well defined and hard. Frequently the site of the fissure is marked externally by a small clavate papilla, or minute muco-cutaneous polypoid growth; this must not be confounded with ordinary polypus, and is not the *cause* of the fissure, but the *result* of the local irritation and inflammation which have been going on. Sometimes the situation of the fissure is indicated by an inflamed and swollen piece of skin, and in this case ulceration through this portion of integument not infrequently occurs, and a small but extremely painful fistula results.

When operating for the fissure this club-shaped papilla ought to be snipped off, or the case may not do well, as it falls down into the wound and retards or quite prevents healing. Of course, too, if a fistula exists, it also must be laid open throughout its whole length, as otherwise no recovery will ensue.

Fissure is very commonly associated with uterine displacement. The successful treatment of this may be sufficient to cure the fissure (if no polypus exists), or at all events the ulcer will afterwards yield to local applications and general treatment. Even if the fissure be benefited by operation, as long as the uterine malady exists, there will be constant danger of a relapse taking place. If in combination with uterine displacement chronic cystitis and spasmodic pains in micturition are present, the surgeon may depend upon it that the case will call for all his skill and patience to bring it to a successful issue.

Gelatinous and fibrous polypi are not uncommon complications of fissure, and are generally situated at its upper or internal end. If the polypus is not removed at the time that the ulcer is divided, failure is certain to result. If the fissure is of recent origin, it may often be cured without operation, especially if it is situated anteriorly. In women this can almost certainly be accomplished. The syphilitic fissure is the most amenable to general treatment, and syphilitic fissures are often multiple. If an operation be required for multiple fissures, one incision through the sphincters will be sufficient.

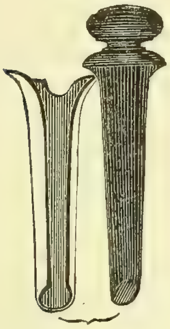
In all cases of fissure, rest in the recumbent position should, as much as possible, be adopted. Mild laxatives should usually be given to keep the bowels open once daily, but diet will sometimes effect this. The domestic remedy of figs soaked in oil, or onions and milk, at bedtime, may be sufficient. I often order a combination in equal parts of confection of sulphur and confection of senna; small doses of sulphate of magnesium or of sulphate of potassium, half a tumbler of Pullna or Hunyadi-Janos water taken in the morning fasting, the compound liquorice powder of the German Pharmacopœia, and the liquid extract of cascara sagrada, are great favorites of mine. It is necessary to alternate the medicines, as one or other seems to lose its effect. All drastic purges should be avoided, but I do not object to small doses of the aqueous extract of aloes combined with nux vomica and iron.

The patient should manage to get the bowels to act the last thing at night, instead of in the morning, as the pain does not continue as long when lying down, and this habit may be brought about by a nightly injection of half a pint of cold water. After the action, ♏ xx to fʒss of liq. opii sed. should be injected with f℥ij of cold starch. As an application, I know of nothing better than the following ointment: Hydrarg. subchloridi, gr. iv; Morphiæ sulphatis, gr. j; Ext. belladonnæ, gr. ij; Ung. sambuci, ℥j, to be frequently applied. I have effected many cures with this ointment alone. A very light touch with the nitrate of silver, not to cauterize, but to sheathe the part with an albuminate of silver, is occasionally advisable. Should one little spot in the ulcer be particularly painful, it is probably due to the exposure of a nerve filament, which may be destroyed by the application of the acid nitrate of mercury. If there be severe spasm of the sphincter, extract of belladonna should be thickly smeared around the anus over the muscle. If ointments disagree with the sore, finely powdered iodoform may be tried, mixed with white vaseline, or lead-water in combination with opium. Painting over the part with liq. plumbi subacetatis is a most successful remedy. But it must be acknowledged that the most carefully devised and carried out general treatment frequently fails.

If the base of the ulcer be gray and hard, and if on passing the finger into the bowel, the sphincter is found hypertrophic and spasmodically contracted, feeling as it often does like a strong India-rubber band with its upper edge sharply and hardly defined, nothing but the adoption of operative measures to prevent all action of the muscle, for a greater or less length of time, is likely to effect a cure of the fissure. The operation may be aided by introducing a speculum; this enables the surgeon to see exactly where his knife should go, and the parts are also rendered tense, so that their division is facilitated; the incision should commence a little above the upper end of the fissure, and should terminate a little beyond its outer end, so that the whole sore may be cut through. As a general rule, the depth of incision should not be less than a quarter of an inch.

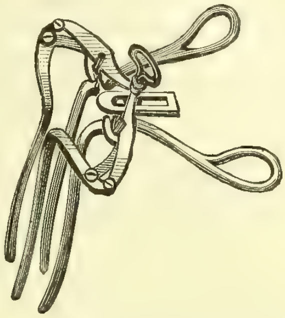
If the outer end of the fissure be marked by a swollen and inflamed piece of skin, it is better to remove that with a pair of scissors, for by so doing the healing process is greatly expedited; the small polypoid growth also, so often found in fissure, must be at the same time snipped off, and a fistula, if such exist, laid open. If the fissure is quite dorsal, the fibres of the muscle should be divided somewhat laterally. A small piece of cotton-wool should be placed in the wound, and allowed to remain for from twenty-four to forty-eight hours. The bowels must be kept confined for two or three days after the operation.

Fig. 1188.



Anal speculum.

Fig. 1189.



Four-bladed anal speculum.

Usually there is no occasion to keep the patient in bed; a few days' rest on the sofa suffices. If, however, there be any uterine complication, the patient must be kept entirely at rest and lying down until the wound has soundly healed, as otherwise the wound will not close, or, what is worse, unhealthy ulceration will supervene.

I come now to the consideration of the *small circular ulcer* usually situated higher up in the bowel than fissures are, and differing from them somewhat in symptoms, but not in treatment. The common situation of the small circular ulcer is above, or about the lower edge of, the internal sphincter. There is less severe pain at the moment of defecation, but it comes on from five minutes to a quarter or half an hour after that act, and then is quite as intolerable as that resulting from fissure. These minute ulcers are more difficult to find than fissures, as they often cannot be seen without using a speculum, or getting the patients to strain violently, which they will not do for fear of exciting pain.

An educated finger detects these ulcers directly; they feel much like the internal aperture of a fistula, but their edges are harder, and therefore more defined, and there is no elevation above the surface of the surrounding mucous membrane, as is frequently the case in fistula when a pouting opening exists. These ulcers often burrow, and then they become the internal openings of blind internal fistulæ. A great many apparently anomalous symptoms are produced by small painful ulcers of the rectum: retention of urine, pain in the back, and pain and numbness down the back of the legs, leading to unfounded fears of paralysis, may be mentioned as not uncommon.

I cannot conclude my remarks on fissure and painful ulcer of the rectum without adverting to a mode of treatment which I have practised with success, especially in cases in which a cutting operation has been contra-indicated. I refer to dilatation. Originated by Récamier and much practised by Dolbeau, this manœuvre, when properly carried out, cures fissures and ulcers on the same principle as dividing the sphincter with the knife, by paralyzing it until the ulcer has healed.

The patient should be thoroughly anæsthetized, and then the two thumbs should be introduced, one after the other, taking care to press the ball of one thumb over the fissure and the other directly opposite to it; this prevents the fissure from being torn through, and the mucous membrane from being stripped off. The thumbs are gradually separated, and the stretching is then repeated in the opposite direction, that is, at right angles, and then in other directions until every part of the anus has been dilated. Considerable pressure should then be applied to the sphincter muscles all around, pulling apart the anus with four fingers, two on each side, and kneading the muscles thoroughly; by thus gently pressing and pulling, the sphincters completely give way, and the muscle, previously hard, feels like putty. This will occupy at least five or six minutes to do thoroughly; there is scarcely more than a drop or two of blood seen, but for a few days extravasation is noticed about the anus. This operation appears, as far as I know, to be quite safe, and very little pain follows, much less indeed than one would expect. Many years ago I was in the habit of subcutaneously dividing the sphincters in cases of fissure, and just recently Mr. Pick, of St. George's Hospital, has spoken favorably of the method; for my own part I gave it up, because there is great difficulty in knowing whether enough of the sphincter muscles has been divided; also, when the patient is under ether, the muscle has no tension, and it is really impossible to cut with precision. I also found much pain after the operation, and very uncertain results. Abscess occurred in more than one instance. If the surgeon wants to avoid cutting, dilatation is on the whole very satisfactory, and I have very rarely failed to cure a *simple* fissure in this way. It is well to put half a grain of morphia into the rectum, and to apply cold water very freely, which soon does away with suffering. It happens sometimes that the patient derives more relief from hot water than from cold. After the stretching, the bruising looks really alarming, but it soon passes away, and I have only rarely seen an abscess follow.

PROCTITIS.

Inflammation of the rectum may occur in both a chronic and an acute form. The symptoms are a sensation of heat and fulness in the rectum, frequent desire to go to stool, and great tenesmus; there may be a discharge of blood and mucus. With these symptoms impaction may be suspected, but a digital examination will settle that point.

The acute form of the disease is very rare in this country, and is generally produced by some mechanical cause, such as the introduction of a foreign body. I call to mind a case of acute proctitis which resulted as a consequence of an unnatural offence committed by a husband on his wife. Here there was no doubt of the rectum being acutely inflamed, as there was a well-marked blush around the anus and over the buttocks, as well as severe pain and tenderness in the rectum. But I saw no discharge. The most obstinate constipation was present, but was overcome by the use of O'Beirne's long tube as soon as it could be passed.

Idiopathic acute inflammation of the rectum resembles dysentery in its symptoms, but is distinguished from it by the absence of abdominal pain or tenderness and of severe constitutional disturbance; the pain is generally confined to the sacrum and perineum; the bladder is often sympathetically affected, and there is not infrequently difficulty in passing water.

The most effective treatment for this condition would be the use of leeches around the anus, hot baths, injections of water in small quantities as hot as could be borne, to which might be added a drachm of Battley's sedative. A hot bath, followed by a hypodermic injection of morphia, is likely to be of benefit. The patient should keep the recumbent position, and take very light, unstimulating nourishment; no irritating purges should be given. If it be necessary to relieve the bowels of their contents, a flask of warm olive oil as an enema is the best that can be employed. I have seen very few such cases in this country, but they are not very uncommon in hot climates.

The chronic variety of proctitis occurs in old people, and is best treated by injections of starch and opium, and by the internal use of such medicines as turpentine, aloes, confection of black pepper, and copaiba. I usually order frequent and small doses of Barbadoes aloes; these act as a stimulant to the rectum, and induce healthy action, and very soon the disorder subsides. Hamamelis is another useful remedy; it is in fact rapidly curative in some cases. It may be used as an injection, and may also be administered by the mouth.

Ulceration and Stricture of the Rectum.

Ulceration extending above the internal sphincter, and frequently situated entirely above that muscle, is not a very uncommon disease; it inflicts great misery upon the patient, and, if neglected, leads to conditions quite incurable, and the patient dies of exhaustion unless extraordinary means are resorted to. In the earlier stages of the malady, careful, rational, and prolonged treatment is often successful, and the patient is restored to health; but not so in severe and long-standing cases. Ulceration of the rectum can only be mistaken for malignant disease; but with care and a well-educated finger an error in diagnosis should be a great rarity, though I must confess that I have made the mistake myself.

As the earlier manifestations are fairly amenable to treatment, it is of the utmost importance that the disease should be recognized early.

In the majority of these cases, the earliest symptom is morning diarrhœa, and that of a peculiar character; the patient will tell you that the instant he gets out of bed he feels a most urgent desire to go to stool; he does so, but the result is not satisfactory. What he passes is generally wind, a little loose fecal matter, and some discharge resembling coffee grounds both in color and consistency; occasionally the discharge is like the "white of an unboiled egg," or a "jelly fish;" more rarely there is matter. The patient in all probability has tenesmus, and does not feel relieved; there is a somewhat burning and uncomfortable sensation, but not actual pain; before he is dressed, he very likely has again to seek the closet; this time he passes more feces, often lumpy, and occasionally smeared with blood. It may also happen that after breakfast, hot tea or coffee having been taken, the bowels will again act; after this he feels all right, and goes about his business for the rest of the day, only, perhaps, being occasionally reminded by a disagreeable sensation that he has something wrong with his bowel. Not by any means always, but at times, the morning diarrhœa is attended with griping pain across the lower part of the abdomen, and great flatulent distension. All these symptoms are also met with in cases of malignant disease. When a medical man is consulted, the case is, in all probability and quite excusably, considered one of diarrhœa of a dysenteric character, and is treated with some stomachic and opiate mixture, which affords temporary relief. After this condition has lasted for some months, the length of this period of comparative quiescence being influenced by the seat of the ulceration and the rapidity of its extension, the patient begins to have more burning pain after an evacuation; there is also greater straining, and an increase in the quantity of discharge from the bowel; there is now not so much jelly-like matter, but more pus, more of the coffee-ground discharge, and more blood. The pain suffered is not very acute, but very wearying; it is described as like a dull toothache, and is induced now by much standing about or walking. At this stage of the complaint the diarrhœa comes on in the evening as well as in the morning, and the patient's health begins to give way—only triflingly so perhaps, but he is dyspeptic, loses his appetite, and has pain in the rectum during the night, which disturbs his rest; he also has wandering and apparently anomalous pains in the back, hips, down the leg, and sometimes in the penis. There is yet another symptom present in the later stages, marking the existence of some slight contraction of the bowel—alternating attacks of diarrhœa and constipation; and during the diarrhœa the patient passes a very large quantity of feces.

These seizures are attended with severe colicky pains in the abdomen, faintness, and not unfrequently sickness.

As the ulceration extends, attempts at healing take place; these result in infiltration and thickening of the mucous and submucous tissues, and consequent diminution of the calibre of the bowel, so that real stricture of various forms supervenes. Coincident with all this there results a gradual loss of the contractile power of the rectum, and almost complete immobility, so that the lower part of the gut is converted into a passive tube through which the feces, if fluid, trickle; but, if solid, stick fast until pushed through by fresh formations above them. Invariably also there is loss of power in the sphincters. When diarrhœa is present, the patient has little or no control over his motions. Usually by this time abscesses have formed, or are in process of formation, and these breaking soon become fistulæ. I have seen persons with eight external orifices, some situated three inches or more from the anus.

On examining these cases of ulceration of the rectum, the surgeon may often feel, in the earlier stages, an ulcer situated dorsally about one and a half inches from the anus, oval in form, perhaps an inch long by half an inch wide, surrounded by a raised and sometimes hard edge; there is acute pain caused on touching it, and it may be readily made to bleed. With a speculum he can distinctly see the ulcer, the edges well marked, the base grayish or very red and inflamed-looking, the surrounding mucous membrane being probably healthy; in the neighborhood of the ulcer may often be felt some lumps, which are either gummata or enlarged rectal glands. This is the stage in which the disease is often curable. At a later period of the malady, he will observe deep ulcers with great thickening of the mucous membrane, often also roughening to a considerable extent, as though the mucous membrane had been stripped off. At this stage there are generally, outside of the anus, swollen and tender flaps of skin, shiny, and covered with an ichorous discharge; these flaps are commonly club-shaped, and are met with also in malignant disease; but during the early development of the disease *no ulceration is found near the anus, nor at the aperture.* I must positively repeat that the large majority of these cases do not commence by any manifestation at the anus, such as growths or sores; occasionally a fissure may be the first lesion, and the ulceration may extend from the wound made in attempting to cure it; this is, however, the exception to the rule. So definite is this external appearance in long-standing disease, that one glance is sufficient to enable an expert to predicate the existence of either cancer or severe ulceration; these external enlargements are the result of the ulceration going on in the bowel, and the irritation caused by almost constant discharge. The ulceration may be confined to a part of the circumference of the bowel, or it may extend all around, and for some distance, but not usually more than four inches, up the rectum.

It also probably will have travelled downwards close to the anus, and there the pain is sure to be very severe, because the part is more sensitive and more exposed to external influences and accidents. When the disease has reached this stage, of course stricture and most probably fistula will be present, as I have already mentioned; and possibly, but not frequently, perforation into the bladder, the vagina, or the peritoneal cavity, may occur. The state of the patient is now most lamentable; his or her aspect resembles that of a sufferer from malignant disease, and no remedy short of lumbar colotomy offers much chance of even prolonging life. You may relieve these patients, but you can rarely do more; a cure can scarcely be expected. I have seen ulceration utterly destroy both the anal sphincters, so that the anus was but a deeply ragged hole.

A low form of peritonitis is a not uncommon complication of ulceration and stricture. It is attended with considerable pain in the abdomen, often intense for a short period. There are generally one or more tender spots, tympanites, and often vomiting, especially on first assuming the erect position in the morning; generally the pain is brought on by standing or moving about. These attacks are sure to end in diarrhœa.

When making a post-mortem examination in such cases, I have observed effusion into the peritoneal cavity and often numerous old and recent adhesions between the intestines; the peritoneum is also thickened. In bad cases the whole of the rectum and even the sigmoid flexure may be involved in ulceration, and great thickening and contraction of the calibre of the bowel, caused by the attempts at repair, may be observed; in various parts, large bridges of indurated muscle are exposed, and the mucous membrane is strangely roughened. I have seen more than one case in which necrosis of the sacrum had taken place.

In the treatment of these attacks there should be perfect rest in bed, with spare diet; opium may be given freely; fomentations relieve pain, but I have not seen any benefit result from counter-irritation, except by an ordinary linseed or mustard poultice. I have often found that calomel and opium, given for some time, are advantageous in these cases.

From the notes of my cases in St. Mark's Hospital, I find that out of 110 patients with ulceration and stricture, 92 were females and 18 males. Out of the 110, 49 had undoubtedly suffered from constitutional syphilis, while 9 had some syphilitic symptoms, but not such as were decisive, so that I think that this number should be deducted from the whole number, 110, before considering the statistics of the remaining 101; we then find 49 who were most undoubtedly syphilitic, and 52 who as undoubtedly had never contracted syphilis, and many of whom had never had any venereal disease at all. These statistics differ from those published in my work on Diseases of the Rectum, showing a less proportion of syphilitic patients; but this may be merely accidental, and a further series may again reverse the results. Many of my patients have been subjected to colotomy in the lumbar region, and for the most part have done well, and I believe several (eight or nine) are now alive. Two of the women have married since the operation, and one has borne a child. For the relief of stricture and ulceration I have performed colotomy thirty-five times.

In sixteen cases I have performed Verneuil's operation of linear rectotomy, but always with the knife, never with the écraseur or galvanic cautery, as he has recommended.

This is the essence of Prof. Verneuil's operation: The whole stricture must be divided from its upper edge down to the coccyx, and through its entire depth. Thus a deep drain is made, from which all discharges freely flow, and as this heals up, the ulceration ceases, and the stricture is sometimes cured.

The patient being in the lithotomy position, the surgeon passes his finger through the stricture as a guide, then introduces a long straight knife, and, when its point is fully above the stricture, cuts firmly down right through it in its whole depth, even to the sacrum if necessary, and brings the knife out at the tip of the coccyx. By keeping to the median line the bleeding is but trifling, and the whole of the diseased structure will have been cut through. So rapidly beneficial is this operation that in forty-eight hours I have seen night-sweats arrested, and a patient who seemed about to die rally, and eat and drink, and get well from that moment; morbific discharges, instead of being absorbed, run out, and the patient is not poisoned. The wound should be well syringed, and the parts kept perfectly clean by injecting a very weak carbolic lotion (1 in 60). I always use dry absorbent cotton-wool as the dressing, sometimes carbolized, and I only want my patient washed at most twice in the day; too frequent use of any fluid, carbolized or not, soddens and weakens the granulations; dry dressings are those which I advise. Many of these patients have done well, and I have a record of at least fifteen permanent cures; but in others the operation has failed, and I have seen a return of the disease after even three or four years. In the after-treatment I often place a tube in the wound, keeping it in at night, which tends to prevent contraction.

Many of my cases have been treated by dilatation, assisted in some instances by small incisions; stricture of the rectum, however, is a disease infinitely more uncertain, more prone to relapse, and more difficult to treat, than stricture of the urethra. In some few cases, immense good has resulted from the long-continued administration of iodide of potassium and perchloride of mercury; but on the other hand, often when it has been expected to be of benefit, no curative result has followed. On the whole, therefore, I place no great faith in specific remedies, although I always use them with tonics when I feel that the ulcerations are of syphilitic origin.

On summing up my own cases, hospital as well as private, I can in brief state that in women rather more than 50 per cent. have suffered from undoubted constitutional syphilis, and that in men about 40 per cent. have been in the same position. Among the causes of the ulceration, etc., in those who showed no evidence of syphilis, I may mention tuberculosis (not so uncommon as is generally supposed); dysentery and diarrhœa, usually following prolonged residence in tropical climates; obstinate, long-standing constipation; injuries to the uterus and vagina in parturition; and operations on the rectum in persons of bad constitution; but will these causes account for all the cases? I am obliged to say that I do not think so, and to confess that in many of these cases I do not know the cause. If we could answer the question why ulceration and stricture are so much more frequent in the female than in the male, we should possibly have a clue; but for my part I cannot see that any satisfactory reply has been given to this question, more than it has to another, viz., Why is epithelioma comparatively seldom found in the rectums of women?

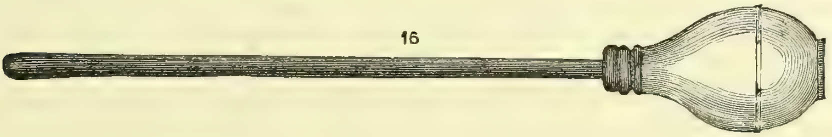
In connection with this part of the subject, I may say that I am altogether at variance with some French authorities, such as M. Gosselin, and some eminent American surgeons, such as the late Dr. Erskine Mason, who hold that the vast majority of cases of stricture and ulceration, not cancerous, result from contamination by the discharges from "soft sores" or "chancroids." I have gone very carefully and fully into the consideration of this matter, and I cannot too strongly and emphatically express my opinion that the ulceration which leads to stricture is the result of tertiary syphilis, and not of chancroid.

My experience of soft sores near the anus is that they speedily heal under proper treatment, and I have seen many cases cured in a few days by cleanliness and the use of a tartrate-of-iron lotion; and though these patients have been seen from time to time for other ailments, no ulceration or stricture of the rectum has been found to ensue.

There are no maladies more baffling to the surgeon than ulcerations and strictures of the rectum, and, as I have before said, they are often quite incurable, and nothing affords relief save colotomy. It is not quite impossible that, after this operation, the ulceration and stricture may get well, and that then the surgical opening in the loin may be closed; this I have now in three cases successfully accomplished, but, on the other hand, I have frequently tried it and failed. In cases of circumscribed ulceration, I have great confidence in the efficacy of rest in the recumbent position, and of a wholly, or nearly, fluid diet, and I consider that milk should be the essential element of food in these cases.

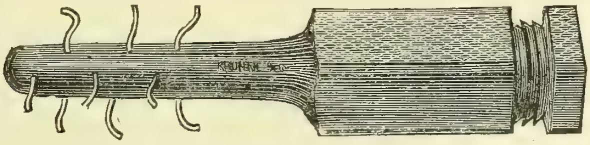
When the ulceration is deep and contraction has commenced, the disease is much more serious, and a very doubtful prognosis should be given. Still, if only the patient will submit to proper treatment for a lengthened period, a good deal may be done in all cases. In these, rest is even more important than it is in the earliest stage of the affection. Often the ulceration induces such an irritable condition of the rectum that nothing will be retained—neither any injection, suppository, nor ointment; I have found that bismuth and charcoal, taken internally, will generally soon overcome this excessive irritability. Subcarbonate of bismuth may also be tried on the mucous membrane itself by means of insufflation. Iodoform also is a very potent remedy. This, when continuously used, may soothe the rectum, relieve pain, and promote healing. As a rule, I prefer ointments to suppositories or injections. The improved American instrument for the application of ointments obviates all difficulties of introduction, and I am sure that this irritates less than other methods of medication; all kinds of sedatives, opiates, and astringents may in turn be tried. I have seen the following formula most efficacious: Bismuthi subnitrat., ʒij; Hydrarg. subchloridi, ℈ij; Morphiæ, gr. iij; Glycerinæ, ʒij; Vaselini, ℥j; this is a very sedative application, and sores seem to be benefited by it speedily. Subacetate of lead and milk (ʒj to f℥j), with belladonna and opium, will be found serviceable; all sorts of astringents may be employed; rhatany, friar's

Fig. 1190.



Rectal insufflator.

Fig. 1191.



Instrument for application of ointments to rectum.

balsam, zinc (the permanganate), copper, iron, nitrate of silver, etc. The last, carefully used in not too strong solution, is one of the most admirable applications, often inducing in an ulcer a healthy appearance, and causing granulation; so too, is the tartrate of iron in the proportion of ten grains to the ounce of water. Fuming nitric acid, and strong carbolic or chromic acid, applied under certain conditions, are potent remedies; they often allay pain and start healing processes afresh, but they are double-edged tools, and must be used with great discretion, and with a distinct object in view.

In ulceration, when the least stricture exists, soft bougies may be always employed, but it must be remembered that to do any good they must be used with the greatest gentleness. A bougie of too large a size should never be employed; no greater mistake can be made than to suppose that the larger the bougie that can be got in the better; the surgeon should keep below the size that can be well borne, rather than at all above it; in the one case good may ensue, in the other, irritation and retrogression are seen to take place; a patient should never be given an ordinary bougie to use for himself, always an India-rubber one, and conical, if the stricture is more than two inches from the anus.

But if the constriction is only about an inch or an inch and a half from the anus, the patient may be given a vulcanite conical tube furnished with a collar, to which tapes are fastened to keep it in the bowel, and also to prevent it from going up the rectum; it may be passed and worn at night, if its introduction can be accomplished without any severe pain. When strictures are slight, and not very long, but annular in form, division in a few places with the knife, followed by judicious treatment with the tubes, may be very beneficial and even curative. The division I usually make at four points, and I take care just to cut through the induration, and reach the healthy tissues beneath, but not to go deeper; the bowel should be filled with well-oiled lint or wool for twenty-four hours, and then the tube introduced and worn, only taking it out for the bowels to act, and to wash out the rectum with some antiseptic lotion. I prefer Condy's fluid or thymol, if the patient himself applies it, as less dangerous than carbolic acid. I am of opinion that carbolic acid, if strong, is too irritant.

In those cases in which the ulceration is extensive, and constriction so tight that a passage barely exists, or in which the lower part of the rectum is now merely a passive tube through which there is a perpetual leaking of semi-fluid feces, some relief may be afforded by dividing the fistulous passages, which are nearly always present, with the elastic ligature. The knife is very likely to cause severe hemorrhage, as the divided vessels can neither retract nor contract in the hardened tissues.

Constitutional treatment here is of no avail. Lumbar colotomy is the patient's only chance.

Stricture of the rectum without ulceration is a somewhat uncommon affection. Its pathology corresponds to that of organic stricture of the urethra; that is to say, there is an inflammatory deposit in the submucous tissue, and an accompanying spasm of the muscular coat. I have seen strictures of the rectum so tight that I could not get the end of my little finger into them; but when the patients had been brought well under the influence of an anæsthetic, I have been able to pass one or two fingers through easily.

How inflammation and thickening are set up in the connective tissue of the bowel, it is difficult to say. It may be that straining to evacuate the contents of the bowel forces down the upper part of the rectum into the lower, thus causing an intussusception, and bringing the part within the grasp of the sphincter muscles; and I have often thought that this condition might be the starting point of the irritation. I have in some few cases had a suspicion that long-continued pressure of the child's head in labor has been the exciting cause, bruising of the bowel having perhaps taken place. Possibly, also, inflammation may be induced by the passage of very dry and hardened feces, though doubtless this condition may obtain for years, as it often does in old people, without producing stricture.

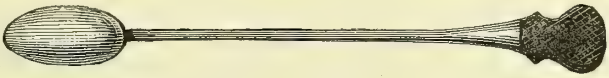
I have seen one case in which the frequent and rather rough use of an enema-pipe produced a stricture. It is stated in some works that the stools in stricture are thin, long, and pipe-like. According to my experience, such stools occur far oftener in spasm of the sphincter, enlarged prostate gland, enlarged retroverted uterus, and tumors of the pelvis generally. In true stricture, on the other hand, the stool is in very small broken pieces, the feces having no actual form, and looseness often alternating with this lumpy condition.

The discharge in simple stricture is like the white of an unboiled egg, or a jelly fish, and is passed when the bowels first act. There is no discharge looking like coffee-grounds, such as is constantly seen in ulceration, nor is there the morning diarrhœa which we find in that complaint. The pain is generally referred not to the bowel itself, but to distant parts, notably the penis, the perineum, the lower part of the back, the thighs, under the buttocks, and occasionally the stomach.

A stricture of the rectum, resulting entirely from muscular spasm, is a thing that I am very much disinclined to believe in. I am of opinion that these strictures exist only in the mind of the surgeon, who has been misled by the bougie catching in a fold of the gut, or against the promontory of the sacrum. If in doubt as to the existence of a stricture, the surgeon should use a long and very elastic enema-tube, and inject fluid as he passes it, so as to distend the gut and remove any intussusception of the upper part of the rectum. This condition, I think, has often been mistaken for stricture, as unless the bougie goes directly into the aperture of the invaginated portion of the gut, it gets into the sulcus at the side, which is a *cul-de-sac*, and which prevents the instrument from passing.

In exploring the rectum, I use vulcanite balls, olive-shaped bodies of different sizes, mounted on pewter stems, with flattened, roughened handles.

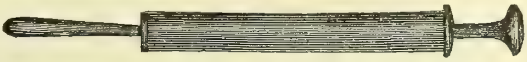
Fig. 119



Instrument for detecting rectal stricture.

They bend easily to any form; and by their use I can be certain of detecting a stricture. For when they pass, or on quietly withdrawing them, the ball is felt to come suddenly, and perhaps with some difficulty, through the constriction.

Fig. 1193.



Rectal syringe.

In cases of stricture where there is great spasm with a small amount of organic disease, much good may be done by the use of conical bougies. Opium or belladonna with oil should be injected previously, and the bougie should be smeared over with blue ointment, which is tenacious and lubricates well. If the instrument cannot be quickly passed, it is better not to persevere, as irritation will be set up and damage done. I strongly disapprove of forcible dilatation, such as that produced by Todd's dilator, as obstinate ulceration only too often results; the amount of pressure made cannot be gauged.

The only kind of stricture without ulceration which in my opinion should be divided, is that in which the constriction is semicircular or annular, and feels to the touch as though the bowel were encircled by a cord. These strictures are so resilient that, even if dilated to their fullest extent, they will very soon return to their previous state of contraction. All other strictures without ulceration I treat by gentle dilatation with conical bougies, very gradually increasing the size of the instrument. I pass a bougie twice or thrice a week, or daily, but not often the latter, being guided by the nature of the case; that is, I never set up irritation if I can possibly avoid it.

As all strictures of the rectum show a marked tendency towards return, patients should be warned never to be long without having the bougie passed, and, as soon as any of the old symptoms recur, at once to obtain treatment; if this advice be acted upon, but little fear need be entertained of a dangerous relapse, and I have now a very large number of patients who have been in this way kept for ten years and upwards in perfect comfort.

Stricture of the rectum cannot be *quickly* and *permanently* cured by any means; an experience of nearly twenty-five years has never shown me a single case quickly cured, which has not as speedily relapsed.

Cancer of the Rectum.

Cancer of the rectum usually runs its course in about two years. In many instances the duration of life is much less. I have watched a case of encephaloid which terminated fatally at the end of four months from the appearance of its earliest symptoms. Colotomy was performed by me when I first saw the patient, two months before death; but I do not think that it delayed the progress of the disease one day, although it afforded relief from excruciating pain. On the other hand, I have seen many cases of scirrhus and epithelioma where the patient lived quite four years and a half (and even longer) without any surgical interference.

Cancer is commonly a disease of middle life, but I have seen encephaloid rapidly fatal in a boy of seventeen; and some years ago there was in St. Mark's Hospital, under the care of my colleague, Mr. Gowlland, a boy, not thirteen, with cancer of the rectum. Scirrhus and epithelioma in old people usually run a very slow course, which may be accounted for by the fact that in old people the vital forces are sluggish in disease as in health.

It has been said that cancer is more frequent in women than in men. As regards the rectum, this is directly the reverse of my experience. In my statistics many more men are victims than women. From my experience, too, there seems to be no ground to consider cancer of the rectum as a hereditary malady.

Some varieties of cancer may in their early stage be only and purely local. But this stage is of very short duration, and the above statement is hardly, certainly not practically, true of the more malignant forms. By this I mean that as soon as a growth exhibits itself, so as to be noticed by the patient, the disease is commonly already constitutional, and the system is infected.

As a rule, cancer of the rectum during some part of its course is most horribly painful, the function of the part enhancing the suffering; but I have seen patients in whom there has not been excessive pain, particularly in the early stages. In the more advanced periods of the malady the pain often becomes unremitting, from the fact that many nerves become involved, and are pressed upon or stretched, the neighboring organs thus becoming seats of separate pain, even if they are not actually touched by the growth. I had a patient with cancer, which, commencing in the rectum, involved the whole cavity of the pelvis, and pain down the right sciatic nerve was one of his most distressing symptoms.

The forms of malignant disease usually described as occurring in the rectum are epithelioma, scirrhus, encephaloid, colloid, and melanosis. I think that I have placed them in their order of frequency. I have never seen a melanotic tumor of the rectum. I have seen many colloid tumors, but I am not sure that encephaloid may not be colloid, or pass into it. From my own clinical observation I should be inclined to say that in cancer of the rectum it is often very difficult, if even possible, to make any distinction between broken-down scirrhus and epithelioma. I have seen cancers of the rectum stony hard at one part and quite soft at another.

Malignant growths are commonly found seated within three inches of the anus, but often extend higher up, the most rapidly dangerous being about the upper part of the rectum and the lower portion of the sigmoid flexure. When cancer occurs near the anus, it may extend upwards beyond the reach of the finger, but more frequently it does not, and the whole extent of the disease can be ascertained. If epithelioma begins at the anus itself, it may extend upwards for a variable distance, usually, however, not so far as to put excision out of the question. There is in cancer of the rectum a peculiar odor, which one cannot describe, but which once recognized will rarely be forgotten. In my opinion the odor is pathognomonic. In scirrhus and encephaloid, the mucous membrane may for a time remain quite smooth and unaffected, though adherent to the growth below. In epithelioma, the mucous membrane seems to be implicated from the first throughout, and, even when the growth is considerable, will be found movable over structures beneath.

Scirrhus is often found as a hard tumor seated in the rectum over the prostate gland, and, although it may not have arisen from the gland itself, nor invaded it at all, yet it is remarkably adherent to it.

The more malignant forms of cancer do not exist long in the rectum before secondary deposits occur in the lumbar glands, groin, liver, etc. The aspect of countenance which so often attends the cancerous cachexia is very usual, and is seen earlier in cancer of the rectum, I think, than in similar disease of other parts. When the cancerous growth is high up, vomiting, frequent and severe, is an early symptom, even when not much obstruction exists. The onset of cancer in the rectum is often marked by very trivial symptoms. A patient may come into the surgeon's consulting room complaining of no more than a little diarrhœa in the morning, or even of only a little uneasiness in the bowel. He may look thoroughly healthy and strong, and may really think himself well in every respect save for the slight local trouble; yet, on making an examination, it may be found that the disease is advanced beyond all possibility of doing any good. When cancer attacks the uppermost portion of the rectum, or the sigmoid flexure, it runs a more rapid course, and is much more dangerous; indeed, sudden death is not uncommon, as total obstruction takes place quickly, and, unless colotomy be promptly performed, the intestine gives way above the obstruction, and death ensues. Cancerous stricture of the upper part of the sigmoid flexure, or of the descending colon, is not so immediately dangerous, although the obstruction may be total. I have seen cases of this kind in which life has lasted eight weeks or longer.

In regard to treatment, I have never seen any benefit result from the application of caustics to growths within the bowel, but when a cancerous mass protrudes, which, however, is a somewhat rare occurrence, I have relieved pain and got rid of a good deal of the growth by using the arsenite of copper with mucilage as a paste; it does not cause bleeding, and, as far as my experience goes, is free from danger.

The treatment in the majority of cases of cancer resolves itself into an attempt to assuage the sufferings of the patient. Pain is mitigated by the recumbent position, and by sedatives, which should be used externally and internally, opium in its several forms being the most effective agent which we possess. It may be used as a suppository, in which case the best formula is morphia with glycerine and gelatine (three of glycerine to one of gelatine), as this melts very soon, and does not feel like a foreign body in the sensitive bowel. Injections of Battley's sedative, nepenthe, or black drop, in starch, afford great relief. Probably most patients obtain the greatest comfort from hypodermic injections of morphia, but no opiate can be used long without inducing a state of mind almost as unendurable as the pain of the disease; therefore great care should be taken to husband the remedy as much as possible, never using a larger dose than is absolutely necessary, and bearing in mind that it may be necessary to rely upon it, more or less, even for months. I have tried the Chian turpentine, recommended by Mr. John Clay, of Birmingham, but have not been satisfied with its results, and have discontinued its use.

When cancerous growths approach the anus, considerable relief may be obtained by dividing the sphincter muscles; defecation is thus rendered easier, and no possible compression can be exercised. When diminution of the calibre of the bowel is induced by cancer near the anus, Professor Verneuil has proposed free division of the gut in the dorsal median line; this operation I have frequently practised, thereby affording great temporary relief to my patients. In encephaloid of the rectum, much relief from pain and some advantage may be obtained by tearing out the growth by the fingers or the scoop. This must be done boldly, and the whole growth enucleated quickly and resolutely. If only the superficial portions are torn away, hemorrhage may occur to a considerable extent, which must exhaust the patient, and no real benefit will accrue. In the cases in which I have adopted this plan of treatment, I have been surprised to observe that, after the removal of the cancerous growths, the facial appearance of the patients has improved immensely; in fact, they have all lost the malignant aspect, and not until the growths have gradually returned, and with it the poisoning of the blood and tissues, has the countenance reassumed its worn, haggard look. So, also, in respect of health, strength, freedom from pain, appetite, and capacity for sleep, this change for the better has been remarkable.

Two operations have been practised for the relief of rectal cancer: The one is extirpation of all the diseased portions of the rectum; the other is colotomy, lumbar or inguinal, which only professes to relieve pain, and possibly to extend the term of the patient's life. Extirpation of the rectum may be undertaken in any form of cancer which does not necessitate the removal of more than four and three-quarters or five inches of the rectum in the male, and about one inch less in the female. If found closely adherent to the base of the bladder and prostate gland, or to the neck of the uterus in women, the operation is probably not admissible, and certainly not desirable. Again, if any enlarged glands exist in the inguinal or lumbar regions, the operation cannot be recommended. Lastly, I should say that the patient ought not to be so exhausted as to render it doubtful whether the rather severe shock, consequent on the operation, may not greatly endanger life.

The partial removal of the circumference of the bowel is in my opinion most unsatisfactory. In all the cases in which I have removed only part of the wall, there has been either a return of the disease in the rectum, or in the glands in the groin, or in some internal organ, mostly the liver.

Up to the present time I have excised the rectum in its entire circumference in 36 patients. In my early cases my success was less than it has been since; increased experience has taught me better ways of operating and more skill in arresting hemorrhage. I am not nearly as long in completing the operation, and consequently my patients suffer less shock; they rarely lose more than four or five ounces of blood, and are in the average not under ether more than thirty minutes—in many cases, indeed, much less time than that. I never stop to tie bleeding vessels as I go, but put on forceps and leave them hanging. I use an écraseur with whipcord, not wire, for cutting through the bowel. I prefer it because it can be more easily applied, and more accurately adjusted. It might be expected that in my long career I should have excised the rectum in many more cases than I have, but the fact is that few really good cases for the operation present themselves. Cancer often commences high up in the bowel, and only comes into reach after existing for some months. I have seen so many patients with cancer of the rectum who had recently been examined by eminent surgeons, and no disease found, that I have come to the conclusion that the disease existed, but had only very recently come within reach of the finger. Moreover, I have myself examined patients who had very marked symptoms of malignant disease of the bowel, but in whom I could not detect any disease in the rectum, and in less than three months these patients have again presented themselves, and the growth has been felt two inches from the anus.

The mode of operating which I prefer in all serious cases, that is, when more than three inches of the rectum has to be removed, is that which has found most favor with French writers. The surgeon commences the operation by making a deep dorsal incision, beginning just in front of the tip of the coccyx, and carried high up the bowel. I consider this the "key" to the operation; it affords plenty of room and wonderfully facilitates the details, such as securing vessels quickly, and performing delicate dissections of the parts adherent to the prostate and base of the bladder, or to the vagina. Further, it forms a deep drain through which all morbific matters run away, and through which the whole wound can be easily washed out with weak carbolic lotion, or some other antiseptic.

In operating upon the male, a silver catheter should always be passed to steady the urethra and render the deep dissection safe and more rapid. I often keep a large tube in the rectum, after the operation, to favor the escape of flatus, which if retained sometimes causes the patient great pain.

In women, an assistant's finger should be introduced into the vagina to afford the surgeon timely warning of his approach to the mucous membrane. If obliged to take out a portion of the recto-vaginal wall, I am not anxious about it, as in all my cases in which this has been done I have repaired the damage at the time of the operation, and in nearly all successfully. In cases where the disease does not extend very high up the rectum, it is possible to leave the sphincter muscle, and bring down the bowel so as to suture it to the skin. I certainly have not had the success some surgeons claim in such cases. I have several times found the traction so great as to tear out the sutures, and at other times fecal matter has got into the wound, and the sutures have had to be taken out to clear away pus, etc. In two patients only have I had good results, the skin uniting with the mucous membrane very securely; both patients were women, thin, and very good subjects for the operation.

When small portions of the rectum have to be removed, there are several ways in which this can be done, and the surgeon may avoid the dorsal incision and use a horse-shoe one around the dorsal circumference of the anus; getting into the connective tissue, the flap may be turned forwards, the growth removed, and then the flap brought down and sutured to the bowel without sacrificing the sphincters. I have not myself met with a single case in which I could attempt this operation with any chance of success, and I much doubt if it is very practicable. Mr. James Adams, late of the London Hospital, has suggested that colotomy should be performed prior to excising a cancer of the rectum. His arguments in favor of such a step are as follows: "That in cases of any but the slightest degree the operation might prove incomplete, and the disease speedily return; that after complete removal of the lower part of the rectum, the subsequent contraction is often very great, and even at times quite intractable; and that in any case the healing of the wound would be much expedited and the local recurrence diminished by diverting the course of the fecal matter." I have not yet tried the combined operation of colotomy followed by excision, but I am disposed to think that there is much to commend it.

I have found in all cases of excision of the rectum, in those of others as well as in my own, that by the third month after the operation very great contraction will have taken place, unless certain precautions have been practised. The contractions once formed are most difficult of cure, and in fact some are never thoroughly rectified. In all my cases, for years now, I have made my patients, after the expiration of ten or fourteen days from the operation, wear a vulcanite tube in the bowel. This is taken out daily while the bowels are acting, but at other times is constantly retained for some months; the result is that no stricture or contraction of the anal orifice takes place, and that the patients are quite comfortable. In one of my cases a man has been compelled to wear a plug ever since the operation; if he leaves it out for a couple of months, the parts re-contract. I use tubes of three or four inches in length, one end conical to render the introduction easy, and the other ending in a broadish flange to prevent its accidentally slipping into the rectum, and also to enable it to be stitched to a bandage which keeps it in place.

Now what has been my success in the 36 cases in which I have operated since March 2, 1874? Unfortunately, with the very best intentions, accuracy in all particulars cannot be insured in answering this question. Patients, particularly those attended in hospital, go away, and are lost sight of, but I have done all that I could to follow up my cases, and have fairly succeeded, as I know the result in 26. Of the 26 patients,

1 died about 4 years after the operation.
1 " " 3 "
2 " " 2 "
5 " over 18 months "
7 " about 1 year "
5 " from the direct consequences of the operation.
5 I know to be still alive.

Of the 5 living patients, one was operated upon more than seven years ago; the rest within two years. Of the 5 who died from the direct consequences of the operation (that is, within 14 days), 1 died by carbolic-acid poisoning—an assistant unwittingly injecting a strong solution to wash out the wound—the peritoneal cavity being open; 1 from secondary hemorrhage on the 10th or 12th day; 1 from peritonitis, a few days after the operation; and 2 from erysipelas. There still remain the ten patients lost sight of; of these I can only say that they all went from my care after two months, when the early dangers attending the operation had passed away; two I saw after six months, and their cases bade fair to be very successful.

I must contend that the operation in properly selected cases is one likely to afford excellent results, and I am sure that with increased experience the direct mortality may be decreased. Properly, my deaths from the operation *per se* may be reduced to 4, as the carbolic-acid poisoning was absolutely an accident. As to the prolongation of life and the amount of comfort afforded, I think it quite sufficient to justify my recommending the operation in all cases in which the growth can be fully removed. In two of my cases, which did well, I opened the peritoneum and removed a hard mass of glands, and in another case one gland; and I am fully confident that if due precautions are taken, the opening the cavity of the abdomen does not greatly add to the danger.

Since writing the above paragraphs I have performed three more excisions of the rectum, and all of the patients are, so far, doing well.

I shall only quite briefly touch upon the question of colotomy, as the subject has been fully considered elsewhere. Generally, I will say that colotomy is justifiable when an obstruction existing in the rectum, sigmoid flexure, or in the descending or transverse colon, places the patient's life in peril. Also, when an opening has taken place between the rectum and the bladder, or even the vagina high up, the distress in these cases being often exceedingly great. When cancer of the rectum is rapidly advancing, and all treatment fails to relieve pain, then also colotomy may be performed even if no obstruction exists.

I must, however, protest against colotomy being performed simply because a cancer exists in the rectum. Often neither pain nor obstruction will ensue for months, or they may never occur, and the patient may die of some other malady. Of course, if a surgeon at once persuades all his patients who have malignant growths of the rectum to submit to colotomy, under the promise that life will be much prolonged and suffering averted, he will have many cases to report and very good statistics, but I maintain that such statistics are really valueless. In one case, another surgeon performed colotomy three days after the patient had consulted me; there was a growth, but no pain and no obstruction, and the patient was in fair health; he died four months after the operation. In all probability, had he not been operated upon, he might have lived for years. I was once called to Eastbourne, to see a gentleman whom I found suffering from constant diarrhœa; he was wasted to a shadow, and his skin was dry and furfuraceous. I found superficial ulceration in the rectum as far as I could reach, and the mucous membrane was studded with small elevated bodies. I said that the patient was suffering from tuberculosis of the bowel, and that he would die in a few days. I was then asked if I did not think that colotomy was necessary, and was told that a surgeon was coming the next day to colotomize the patient. I fortunately succeeded in stopping the operation: the patient died in three days, and the post-mortem examination showed tuberculous deposits through the whole intestine.

I saw a gentleman not long since who came to consult me about the trouble which he experienced from an opening that had been made in his right lumbar region for the relief of obstruction in the bowel. I found a considerable portion of the descending colon coming out of the wound. He said that the operation had been done two years before, and that he had been said to have cancer. He said that he had never had any severe obstruction in the bowel, but that the surgeon thought that while his health was fair it was better to do the operation, so as to avoid difficulty that was sure to arise in the future. On carefully examining the patient's rectum, I found a very moderate syphilitic stricture, through which a bougie, as thick as my forefinger, was easily passed.

HEMORRHOIDS.

EXTERNAL HEMORRHOIDS may be divided into two varieties: the first including all hypertrophies or excrescences of skin around the anus; the second, sanguineous venous tumors outside of the external sphincter. These are in fact either coagulations of blood in dilated veins, or coagulated extravasations into the connective tissue. The first variety of external hemorrhoids is often a sequel of the second, as, when a coagulum is absorbed, a small flap or tag of skin remains behind, marking its site and liable to give further trouble by accidentally becoming inflamed at a future period. Should this happen, the tag of skin becomes swollen, œdematous, and shiny, and exceedingly painful to the touch; sometimes it ulcerates, or suppuration may take place if the inflammation runs high, and thus a small but painful little fistula may arise. At times the œdema is so considerable as to extend into the bowel, forming a large swollen ring of skin and everted mucous membrane all around the anus.

With regard to the second variety, the *sanguineous venous hemorrhoids*, they are swollen, ovoid or globular, bluish tumors, very hard and exquisitely painful; they can be pinched up between the finger and thumb from the tissues beneath, and they feel as if a foreign body were present there. Sometimes, but rarely, they can by gentle pressure be emptied of their contents; but this process is not followed by any benefit to the patient, as in a few hours they become more painful and larger than before. By irritation they set up spasm of the sphincter and levatores ani muscles so that they are drawn up and pinched, thus adding much to the patient's suffering. Just as he is falling to sleep, a spasm takes place and wakes him up; in addition there is constant throbbing, and the sensation as if a foreign body were thrust into the anus; this excites the desire every now and again to attempt to expel it by straining, which, if indulged in, of course aggravates the pain. Often the patient cannot sit down, save in a constrained attitude, nor can he walk; and when he coughs the succussion causes acute suffering. When the bowels act, and for some time afterwards, the distress is greatly increased. Accompanying all this there are general feverishness, furred tongue, and usually constipation.

Such then are the symptoms of an acute "attack" of external piles, and it must be remembered that one invasion predisposes to another. Now what are the causes of external hemorrhoids, remote and exciting? Amongst the former must be included, obstructions of the liver or portal system, fecal accumulations, and anything rendering the return of blood from the rectum difficult. Therefore, whatever induces constipation of a chronic type, may also be regarded as a predisposing cause of external hemorrhoids. Too good living—especially the consumption of large quantities of meat—free indulgence in alcoholic drinks, excessive smoking, sedentary occupations, etc., are such causes. Among the exciting causes, exposure to wet or cold, friction from clothing, and the use of printed paper as a detergent (especially the cheap papers from which the ink comes off on the slightest friction), the neglect of proper ablutions, and straining, however induced, are in my experience the most common. Not unfrequently a little unusual eating and drinking, without any absolute excess, is the exciting cause; an indulgence in effervescing wines or full-bodied ports or new spirits, being especially dangerous. The earliest symptom is a sensation of fulness or plugging up, and of slight pulsation in the anus; there is also a tendency to constipation, inducing a little straining; this is frequently followed by itching of a very annoying character, coming on when the patient gets warm in bed, keeping him awake for some time, and inducing him to scratch the part. In the morning he finds his anus a little swollen and tender, and if he be an observant person with regard to himself, he will notice after a motion a slight stain of blood.

The *treatment* in such a case should be abstinence from active exercise, with rather spare diet, embracing well-cooked vegetables and fish, but not much meat, and no beer or spirits; even wine is not desirable. If a smoker, the patient must cut down his usual allowance; smoking often causes a sympathetic irritation of the throat and rectum. He may take a warm or a Turkish bath, and should wash the anus night and morning with warm water and Castile soap, after this applying some glycerine and tannic acid, or some calomel ointment, or a lotion composed of one teaspoonful of the liq. plumbi diacetatis added to a wineglassful of fresh milk, which is very soothing. As to medicines, he may take a Plummer's pill, with a little taraxacum and belladonna, for two or three nights at bed-time; and in the morning, fasting, some effervescing citrate of magnesium, phosphate of sodium or sulphate of potassium and sodium, or this draught, which I have found very useful on many occasions: R.—Liq. magnes. carb. f℥ss; potassii bicarb. ℈j; syr. seu tinct. sennæ fʒij; spt. æther. nit. fʒss; aquæ puræ ad f℥ij. One third of a tumbler-full of Friedrichshall water, taken fasting with twice as much warm water, or Carlsbad salts, will also have a good effect.

If the case be neglected, and advice be not sought until active inflammation has set in, and the symptoms I have described are in full force, the surgeon will save his patient much time, pain, and after-trouble, by snipping off the inflamed cutaneous excrescences, or, in the case of the sanguineous tumors, by laying them freely open by transfixion with a bistoury, and turning out the clot. The incision should be made in the direction of the radiating folds of the anus. A little absorbent cotton-wool should be laid into the wound, which will readily heal. It is always well in these cases to ascertain, by means of an injection, whether there be any internal piles associated with the external; if so, they must be attended to, or the patient will probably be made worse by any operation on the external hemorrhoids. If the patient will not submit to operative treatment, the swollen parts should be well smeared with extract of belladonna and glycerine in equal parts, and a warm poultice applied. Sometimes cold is found by the patient to be more soothing; ice should then be constantly applied, or, if this be unattainable, Goulard water with extract of belladonna. I have never seen much benefit derived from leeching, and often much ill.

After having experienced one attack of hemorrhoids, a patient should guard himself against a repetition by simple living, plenty of exercise, abstinence from stimulants and excessive smoking, great cleanliness of the anus, and absolute regularity of the bowels. If medicinal aid be required to insure this, he will find equal parts of the confections of black pepper, sulphur, and senna, a capital remedy; or the German licorice-powder, one teaspoonful of which, two or three times a week at bed-time, generally suffices to keep the bowels acting daily; lastly, the mineral waters, such as Friedrichshall, Pullna, or Hunyadi-Janos, are often of great use. A steady perseverance in the line of treatment which I have suggested will in all probability eradicate the hemorrhoidal tendency.

A favorite prescription of mine to stave off attacks is the following: R.—Magnes. sulph. ʒss; acid. nitric. dil. ♏ x; succi taraxaci fʒj; infus. calumbæ f℥j. This should be taken twice in the day. This medicine acts gently on the liver and bowels, and at the same time is a tonic. After taking it for a week, the patient generally feels wonderfully better. His appetite is good, his bowels are regular, and he is capable of bearing fatigue and enjoying exercise.

Internal Hemorrhoids.—Although during pregnancy external venous hemorrhoids are frequent, and usually pass away after labor, the reverse is the case with regard to internal hemorrhoids; these most frequently make their appearance after parturition, when all the parts are relaxed and uterine involution is going on. I will not attempt to give any reason for this peculiarity; I only state a fact which I have repeatedly observed. As regards the other causes of internal hemorrhoids, they are practically those which also produce external hemorrhoids. In addition, hereditary influence, and diseases of the genito-urinary system, must be included.

I do not share M. Verneuil's view that the *boutonnières musculaires*, described in the section on anatomy, play an important part in the etiology of the disease which we are now considering, mainly on two grounds: first, because the presence of arteries in hemorrhoidal growths is not thus accounted for; and secondly, because it seems to me that the contraction of the circular and longitudinal muscular fibres of the bowel favors, and does not retard, the upward flow of the blood; the button-hole apertures through the muscular walls of the rectum really play the part of valves to support the column of blood going to the liver, and in place of causing stasis prevent it, by opposing regurgitation in congested states of that organ.

As regards the structure and appearance of internal hemorrhoids, three broadly-marked kinds may be observed: viz., the capillary hemorrhoid, the arterial hemorrhoid, and the venous hemorrhoid; at times all perfectly distinct, at other times united in the same patient.

Hemorrhoids of the first variety I should describe as small, florid, raspberry-like looking tumors, having a granular, spongy surface, and bleeding on the slightest touch; these piles are often situated rather high in the bowel. Although so small, the quantity of blood lost from them may be very considerable. In structure they consist almost entirely of hypertrophic capillary vessels and spongy connective tissue, and therefore I think a good name for them is the *capillary hemorrhoid.* They resemble arterial nævi very closely indeed in their microscopic structure, except that they are covered externally by a very much thinner membrane, and consequently are readily made to bleed. Ultimately, the main vessels feeding the growth increase in diameter, and the areolar tissue becomes thickened and more abundant. An exudation of lymph obliterates the capillaries, and so arrests bleeding from the surface. These changes I believe to be the result of slow processes of inflammation. In this way most commonly hemorrhoids of the second variety, *arterial internal hemorrhoids*, are formed. They may be thus distinguished: The tumors vary in size, attain sometimes very considerable dimensions, glisten on their surface, are slippery to the touch, hard, and vascular, and if scratched bleed freely, the blood being bright-red and issuing by jets. If the finger is passed into the bowel it will feel entering into the upper part of each hemorrhoid an artery, pulsating with as much force as the radial, and in many cases of a calibre but little less. On dissecting one of these tumors, it will be found to consist of numerous arteries and veins, freely anastomosing, tortuous, and sometimes dilated into branches, and of a stroma of cell-growth and connective-tissue, the latter most abounding.

The third variety is the *venous internal hemorrhoid*, and in this the venous system predominates. The tumors are often very large. I have seen them quite the size of a hen's egg. They are bluish or livid in color, and they are hardish; the surface may be smooth and shiny, or pseudo-cutaneous; they prolapse very readily, and are often constantly down; they do not usually bleed much, but, if pricked, the contained blood may be either venous or arterial. This form is commonly found in women who have borne children, and who have enlargement or retroversion of the uterus; they often occur about the period of change of life. This form may be called the "passive" kind, and is frequent among spirit drinkers.

I never hesitate to operate on these cases, but I observe certain precautions before doing so; if the liver is in fault, I prescribe careful living and a course of Carlsbad waters, together with shampooing and the cold douche. In women, any uterine complication should be attended to. In men, after the operation, extreme moderation of living should be enforced, the bowels should be kept acting regularly, daily, and stimulants should be interdicted. Sometimes venous hemorrhage occurs a week or ten days after the operation, from the surface of the unhealed wounds; if it be not extensive, it should not be interfered with.

The ordinary *symptoms* of internal hemorrhoids are bleeding at stool, which may continue for some little time afterwards; constipation; a feeling of discomfort and heaviness about the anus and lower part of the rectum; and, lastly, protrusion of the hemorrhoids through the anus. The bleeding is usually the first symptom which attracts the patient's attention to the fact that there is something wrong with his rectum, and its amount and character vary considerably. At first usually slight, it may soon become so severe as to blanch the patient, causing one to hesitate about operating, and making it desirable, if possible, to improve the patient's condition by the enforcement of rest, and by the use of tonics and astringent injections, iron and ergotine being especially useful. Should, however, the hemorrhage not cease very soon, the only thing to do is to operate at once, being most careful while operating to avoid any needless loss of blood. In these cases of great blanching the blood is quite watery, will not clot, and runs out freely from the slightest prick; the operation must therefore be executed very rapidly. I often ligate four hemorrhoids in less than one minute; and in such severe cases the ligature is, in my opinion, the only method that can be safely adopted. Some few months back I was present when, in one of these formidable cases, an operator, contrary to my advice, attempted to remove the piles by the clamp and cautery. The result was that the patient nearly lost his life. I was able to temporarily stop the bleeding by pressure on the abdominal aorta, while ligatures were put on around all the diseased mass; a moderate estimate of the amount of blood lost was three quarts. The character of the bleeding may be arterial, venous, or mixed. The older the hemorrhoids, as a rule, the more venous is the hemorrhage, but, on the other hand, when they have reached a very advanced stage hemorrhoids frequently do not bleed at all, but exude a sero-mucous fluid. Even from the first, a patient with internal hemorrhoids may never have lost a drop of blood, or, what is more probable, may not be conscious of ever having done so. The feeling of discomfort and heaviness in the rectum hardly ever amounts to pain. If there is pain, there is probably inflammation or an ulcer. When the hemorrhoids come down, and are compressed by the sphincters, there will of course be pain, which is relieved by the patient's returning them into the bowel. This protrusion is what annoys the patient most, and urges him to undergo an operation. At first the piles come down during stool, but return spontaneously; afterwards, the patient has to return them by pressure; and lastly, although returned, they will not remain in place if the least exertion be made.

Constipation, which usually precedes the advent of hemorrhoids, is nearly always rendered much more obstinate through the mechanical obstruction which they afford to the free evacuation of the bowels; yet patients will tell the surgeon that they go regularly to stool every morning, and only on cross-questioning them will he elicit the fact that, although the bowels may diurnally respond to the call of nature, their action still leaves much to be desired, and at the best is very protracted and attended with violent straining and loss of blood. A useful question to ask these patients is, "You go to stool every morning, you say; how long do you remain there?"

In old-standing cases with protrusion, there is frequently a difficulty in retaining wind or loose motions; this is partly due to relaxation and weakness of the sphincter, partly to the loss of acute sensitiveness of the mucous membrane at the lower part of the rectum. This sensibility in the healthy subject gives timely warning to the sphincter ani to contract, when necessary.

Before describing the modes of operating which I employ, I may say a few words as to the cases which in my opinion are not well suited for operative interference. The older I get the more convinced do I become that the only really reliable way of treating hemorrhoids is to remove them; the only exception I would make, and that is a very partial one, is in those cases in which, together with hemorrhoids, there is found an ante-flexed or retroflexed uterus.

Here, I would say, the uterine displacement should be first corrected, and then the surgeon should use his judgment, being of course influenced by the urgency of the case and other considerations, as to whether he will operate or not. Even if the wounds heal satisfactorily, the distressing symptoms, bearing down, etc., may continue as before the removal of the piles. So, too, when there are vesical complications, the wounds heal slowly, and with a tendency to ulceration; and when they have at last healed, the patient, as far as his symptoms are concerned, is not much, if at all, improved.

A question often put by the patient to his surgeon is, "If I have my hemorrhoids removed now, will they return?" This query is, in my opinion, best answered in the following way: "If after the operation you will follow the few simple rules of life which I shall give you, you may rely upon it that there will be no return of your hemorrhoids; but if you give full play to the causes which produced them before, there may be such a return." But I am bound to say that, in my own practice, the cases in which I have operated a second time for hemorrhoids have been so few that I could count them on my fingers.

As the result of my experience I may safely say that the tendency to the fresh formation of hemorrhoids has been greatly overrated, and that if patients, after operation, will but attend to their bowels and live simply and rationally, with due regard to the necessity of taking exercise regularly, they need never fear a return of their old trouble. An exception may be made with regard to patients living in tropical climates. Unless great abstinence from alcohol be observed, piles will return.

And now as regards the operation: The night before, and in some cases in which the liver is congested, for two or three nights before, I order a couple of pills, six grains of the pill of colocynth and hyoscyamus, and two of blue pill, to be taken; and the next morning, an hour before the operation, a copious soap-and-water enema should be administered, to make sure that the bowels are empty. I prefer operating early in the morning, as then the patient has the whole day before him in which to shake off the unpleasant effects of the ether and get rid of all pain, and as a consequence a quiet night will be insured, and refreshing sleep.

The different modes of operating are briefly the following: I shall describe only those fully which I myself employ or think well of:—

1. Excision with knife or scissors.

2. Mr. Whitehead's method of excision, combined with torsion and bringing together the divided mucous surfaces.
3. Removal with the écraseur of Chassaignac or the wire of Maisonneuve.
4. The application of various acids and caustic pastes.
5. The injection of carbolic acid or other caustic or astringent fluids into the body of the pile.
6. Punctuate cauterization of Demarquay, Reeves, and others.
7. Linear cauterization of Voillemier.
8. Removal by the galvanic-cautery wire.
9. Removal by the clamp and scissors, applying the actual cautery to arrest hemorrhage.
10. Dilatation of the sphincter muscles.
11. Ligature.
12. Removal by means of the screw-crusher.

Excision is an operation which was much practised in the early part of this century. In cases in which the hemorrhoids are not very large or very numerous, it is in my opinion one of our best modes of procedure, as it is followed by very slight pain only, and rapid recovery ensues. I have had cases in which the wounds were soundly healed on the sixth day.

In performing excision I first gently but fully dilate the sphincter muscles, and employ a retractor to keep the anus well open; I then seize the bowel deeply, above the pile, and cut the latter off at its base, not letting the bowel escape from the volsella until all bleeding has been arrested by torsion of the arteries. Rarely more than two vessels spirt and require twisting. I wait for a little while to see that all hemorrhage has ceased, and then I treat the other piles in a similar manner. After all the arteries have ceased to bleed, I place a piece of cotton-wool, previously saturated in a solution of tannin and water (strength, one ounce of tannin to one ounce of water), within the anus as high as the scissors have cut. In no case has any recurrent hemorrhage taken place. This operation must be done slowly and carefully, and therefore occupies far more time than either ligature or crushing, which is a decided drawback to its employment, as I hold that prolonged anæsthesia is if possible always to be avoided.

About five years ago, Mr. Walter Whitehead, of Manchester, introduced a modification of this old method of excision, which he believes to be more in harmony with the principles of modern surgery. I will give his own description:—

> After it had been decided to excise the hemorrhoids, a day in the following week was fixed for the operation, and in the mean time the patient was very carefully prepared by diet, aperients, and rest. The operation was conducted under chloroform, with the patient in the lithotomy position. As a preliminary measure, the function of the sphincter was suspended by forcible dilatation. Two thumbs were introduced into the rectum, and the circumference steadily kneaded in every direction until all resistance was overcome, and the sphincter rendered absolutely passive. The patulous condition of the rectum thus obtained, enabled the whole mass of piles to be extruded from the anus by introducing two fingers into the vagina and depressing the recto-vaginal wall. The hemorrhoids in size and appearance resembled an average ripe tomato, and were mapped on the surface into four irregular and unequal lobes.
>
> The lobes were next divided into four segments by longitudinal sections in the axis of the bowel and in the furrows marking the intervals between the several lobes. This was accomplished without the loss of any blood. Each portion was then secured in succession by Lund's ring forceps, and dissected with scissors; first transversely from the anal margin, and then upwards in the cellular plane to the highest limit of the hemorrhoidal growth, in this case about an inch and a half. Each segment was thus converted into a quadrilateral, wedge-shaped mass, the base below consisting of the hemorrhoid, and the apex above of the healthy mucous membrane of the bowel.

> The mucous membrane at the highest point was next transversely divided, leaving the hemorrhoid simply attached by loose cellular tissue and by the vessels, proceeding from above and supplying the mass below. The forceps containing the hemorrhoid were then twisted until all connection was severed and the hemorrhoid removed. The divided surface of the mucous membrane was next drawn down, and attached by several fine silk sutures to the denuded border at the verge of the anus.
>
> The other portions having been treated in the same manner, the operation was completed. The sections throughout were made by scissors. The loss of blood during the operation did not exceed a couple of ounces. The patient made a complete recovery, and regained the full capacity to discharge her domestic duties and social engagements.

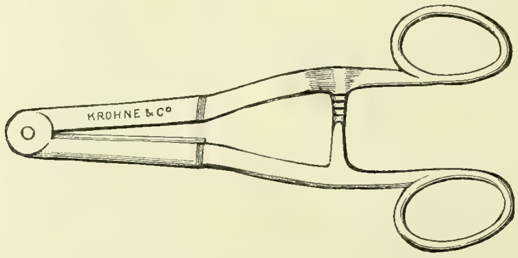
This operation Mr. Whitehead seems to have since modified, and he now cuts out a ring of the bowel commencing at the junction of the skin and mucous membrane; he dissects the piles upward, and then by a circular incision removes the mass (and a portion of the bowel also, I suppose); the cut edges are then brought together. Primary union, Mr. Whitehead says, always takes place, and the patient gets speedily well; he avers that in a large number of cases (200 and upwards), no contretemps has taken place, and by implication no death. Moreover, stricture has never resulted, nor ulceration. I fancy that in small excisions of the bowel for malignant disease, when the mucous membrane and skin have been brought together, such satisfactory results have not been obtained. The method of Mr. Whitehead deserves a full and fair trial, and it shall have it at my hands very shortly; one objection I feel called upon to make, viz., that in inexpert hands much time must be occupied, and considerable loss of blood must take place.

I am quite sure that the frequent failures which are said to take place in other operations for piles, are the result of the very perfunctory and imperfect way in which they are conducted. I have constantly coming to me patients who have only been free from the surgeon for six months, and in whom the piles have returned; this is clearly because real removal has never been performed; a slight clamping, a little burning, removing only the mucous surface of the hemorrhoid, is all that has been done; hemorrhage is only for a time arrested, and the disease continues to advance, having indeed been only very temporarily checked by the means used.

The next seven in the list of operations which I have given, I will pass over, because they have little to recommend them; when they are not uncertain methods they are dangerous, and occasionally they combine both danger and uncertainty of result.

Take, for instance, the "clamp and cautery" method. Mr. Henry Smith, who advocates this plan, lost four cases in 530 operations. Out of 195 patients with whom I followed his recommendation, 2 died in consequence of the operation. On the other hand, in 1800 cases of ligation I have had but one

Fig. 1194.



Clamp for hemorrhoids.

doubtful death. In this case the patient, who was old and very bronchitic, succumbed in 36 hours after the application of the ligature, from acute pneumonia. The "post hoc" here should not I think be considered the "propter hoc," but I record the case. In over 500 cases treated by crushing, I have not had one death from any cause whatever.

I will pass on to *dilatation of the anal sphincters*, so strongly advocated by Messrs. Verneuil, Fontan, Panas, Gosselin, and Monod. The method is as follows: The patient being fully under the influence of an anæsthetic, the surgeon inserts both thumbs into the rectum and dilates gradually, first in the antero-posterior and afterwards in the opposite direction, using an amount of force sufficient to overcome spasm. He continues to manipulate the sphincters until the muscles feel reduced to a thoroughly pulpy condition, so that he can easily insert his whole hand and even draw it out as a fist. The result is that paralysis of the sphincters is fully induced, and this condition will last certainly for four or five days, and possibly for even more. The patient must be kept recumbent for about a week.

In all my operations for internal hemorrhoids I invariably make dilatation a prelude to whatever else I do. This I do for two reasons: first, the rectum is thus rendered so patent that all disease can be seen and dealt with by knife, scissors, or crusher, without making any undue traction on the part; second, all spasm is done away with, and the great element in all such operations, viz., pain, is reduced to the minimum.

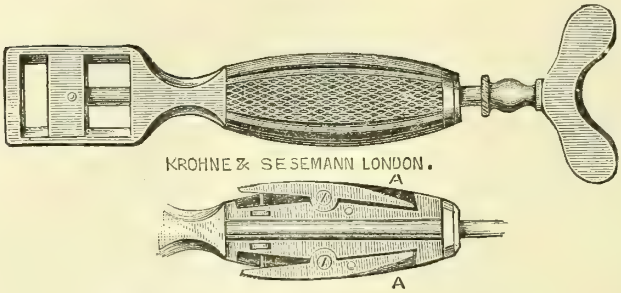
The removal of piles by the *screw-crusher* is in my judgment a very valuable operation. Very safe as regards hemorrhage, and almost painless, the recovery is more rapid than is effected by most other methods.

Mr. George Pollock was, as far as I know, the first to describe and practise the operation by means of a powerful crushing apparatus, and his success was very great; but when I came to try this plan, I found that the instrument he used, which was one designed by Mr. Benham, like a large pair of pincers, was very defective; it was too large, heavy, and clumsy, and did not after all, in severe cases, make enough pressure to insure the thorough destruction of the base of the hemorrhoid. My son, Mr. Herbert W. Allingham, then designed for me an instrument on a totally different principle; it was small, light, and easy of adaptation to the pile, and its power was enormous, being worked by direct screw action and not by lever movement, as in Mr. Benham's pincers. After many trials, Messrs. Krohne & Sesemann, of London, made me a perfect instrument, which I use with much satisfaction and great success.

The crusher is made of solid steel, forming an open square at one end, between the sides of which a second piece of steel slides up and down. The bar is connected with a powerful screw, which drives it firmly home against the distal end of the square, first by a sliding, and lastly by a screwing motion, and thus exerts a great crushing power from which the hemorrhoid cannot escape. By removing a pin, the screw and piston can be easily taken out for the purpose of cleaning. (Fig. 1195.) To aid in the adjustment of the crusher, the hemorrhoid is seized with volsella forceps (Fig. 1196) and drawn through the open square of the instrument.

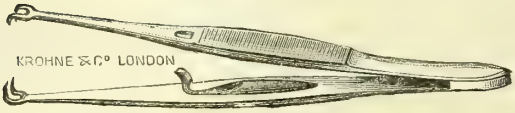
Treatment of Internal Piles by Ligature.—Although I now almost invariably employ the crushing operation, there are still some cases for which I elect ligature: those, for instance, in which the hemorrhoids form a continuous ring with no division into lobes. In these cases the crushing operation has drawbacks. At the sides of the crusher, hemorrhage may occur from laceration of the adjacent portion of the hemorrhoid; the part crushed is not likely to bleed more than any other crushed hemorrhoid,

Fig. 1195.



Screw-crushing instrument for hemorrhoids.

Fig. 1196.

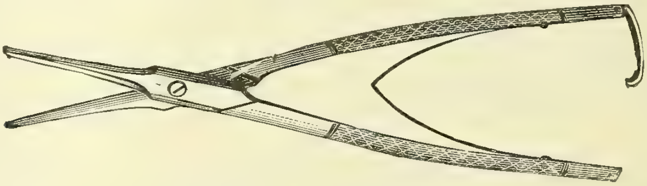


Forceps for grasping hemorrhoids.

but the hemorrhage proceeds from parts wounded in the application of the crusher.

In these cases I always adopt ligation as being the best and safest procedure. The method of operating is as follows: The patient must lie on his right side, on a hard couch, with his knees drawn well up to his abdomen. When he is fully anæsthetized, I gently but completely dilate the sphincter muscles. I then seize the hemorrhoids one by one with a volsella, and with a pair of strong, sharp, spring-scissors (Fig. 1197) separate the pile from its connection with the muscular and submucous tissues upon which it rests; the cut is to be made in the sulcus or white line which is seen where the skin meets the mucous membrane, and this incision is to be carried up the bowel, and parallel to it, to such a distance that the pile is left connected by an isthmus of vessels and mucous membrane only. There is no danger in making this incision, because all the larger vessels come from above, running parallel with the bowel, just beneath the mucous membrane, and thus enter the upper part of the pile. A well-waxed, strong, thin, silk ligature is now to be placed at the bottom of the deep groove which has been made, and, an assistant then drawing out the pile with some decision, the ligature is tied high up at the neck of the tumor as tightly as possible. Great care must be taken to tie both knots of the ligature, so that no slipping or giving way can take place. I myself always tie a third knot; the secret of the well-doing of the patient depends greatly upon this tying—a part of the operation by no means easy.

Fig. 1197.



Spring-scissors for hemorrhoids.

If the pile be very large, a small portion may now be cut off, taking care to leave sufficient stump beyond the ligature to guard against its slipping. When all the hemorrhoids are thus tied, they should be returned within the sphincter; after this is done, any superabundant skin which remains may be cut off; but this should not be too freely excised, for fear of contraction when the wounds heal. I always place a pad of wool over the anus, and a tight T bandage, as it relieves pain most materially and prevents any tendency to straining.

It is advisable to commence by operating upon those piles that are situated inferiorly, as the patient lies, in order that the others may not be obscured by blood, but when the hemorrhoids are numerous, and there are small piles, either anterior or dorsal, it is better to tie the small ones first, as otherwise they may be overlooked. After the operation, the bowels should be confined for three or even four days. I find a solid one-grain opium pill, given as soon as the vomiting after the ether has ceased, and repeated twice, at intervals of two hours, the best article to begin with; afterwards a draught containing laudanum may be substituted. The diet, until the bowels have acted, should be light—spoon-diet in fact. After the bowels have operated, a more liberal allowance of food should be made; I usually begin with fish, followed by meat the next day. I always advise entire abstinence from wine, beer, or spirits, unless there is some special condition indicating the necessity for their use. On the third or fourth night after the operation I order a mild aperient, such as the German licorice-powder, followed the next morning by a hot Seidlitz draught. The first action of the bowels is generally rather painful, and sometimes exceedingly so. A hot linseed poultice applied to the anus immediately after the stool, mitigates the pain and comforts the patient.

The ligatures separate about the sixth or seventh day. I generally give a gentle pull at them daily, commencing the day after the bowels are first relieved; by this plan the ligatures always separate on the fifth or sixth day. The patient should be kept lying down during this period; in fact, the more he observes the recumbent position until his wounds have healed, the better. This usually occurs a fortnight after the operation; in very severe cases it may of course be longer before the wounds cicatrize. The dressing which I employ is of the simplest: a small piece of cotton-wool saturated with oil, or smeared with zinc-ointment, suffices—but it should be introduced with the greatest care and gentleness through the anal orifice. On the night of the operation, the patient may be unable to pass urine, owing to reflex spasm in his urethra; the urine must then be drawn off with a soft catheter, or he will pass a restless night. During the second week after operation, I always make a point of introducing my finger, well anointed, into the patient's bowel, to make sure that there is no tendency to contraction. Should there be such tendency I daily introduce the finger, and, if need be, tell the nurse in charge of the patient to repeat the act at night. Such contraction is of no serious moment, as it only affects mucous membrane, and in any case would pass away in time. But it is as well avoided, as it alarms the patient, who may think that he has got a stricture in place of his piles.

The most common *complication* of internal hemorrhoids is *fissure* or *small painful ulcer;* pain, continuing long after the bowel is relieved, is its most certain sign. *Fistula* is a less common accompaniment of piles. When examining a case of hemorrhoids, the surgeon should never omit to pass the finger well into the bowel, to ascertain that no *stricture*, *ulceration*, or *malignant disease* is present. *Impaction or accumulation of feces* in the rectum or colon, is another complication worthy of mention. Lastly, *polypus* is sometimes found in conjunction with hemorrhoids.

The preliminary dilatation usually suffices to cure a fissure or painful ulcer. It is rarely necessary to divide the muscular fibres at the time of an operation by ligature, since dilatation has come into use. A fistula must of course be laid open. An accumulation or impaction of feces must be broken down and got rid of before the day of operation, as otherwise the wounds will not heal kindly.

A few words must be said as regards the treatment of hemorrhage after operations in internal hemorrhoids.

Primary hemorrhage, if the operation be carefully done, is very rare; occasionally, when large and very vascular hemorrhoids are ligatured, and there is also much superabundant skin cut away, a small vessel will bleed when the patient recovers from shock. This is a trivial matter, and a ligature is easily applied. *Secondary hemorrhage* is of more serious import, and occurs generally in elderly people of broken-down constitutions, or in those who have been very free livers. As far as my experience goes, this hemorrhage is usually more venous than arterial, and occurs at or about the time of the separation of the ligatures.

I have found it utterly futile in cases of secondary hemorrhage to try and place a ligature around the vessels; it is usually the large veins or venous sinuses which are opened by sloughing or ulceration, and when the surgeon introduces a speculum and tries to find the source of bleeding, he can only see that the whole rectum is filled with blood, and on passing his finger will feel a quantity of clots. The best mode of arresting this form of hemorrhage is as follows:—

Pass a strong silk ligature through and near the apex of a cone-shaped sponge, and bring it back again, so that the apex of the sponge is held in a loop of the silk. Then wet the sponge, squeeze it dry, and powder it well, filling up the lacunæ with powdered subsulphate of iron. Pass the forefinger of the left hand into the bowel, and upon that as a guide push up the sponge—apex first—by means of a metal rod, bougie, or penholder, if nothing better can be got. This sponge should be carried up the bowel at least five inches, the double thread hanging outside of the anus. When it is so placed, fill up the whole of the rectum below the sponge, thoroughly and carefully, with cotton-wool well powdered with the iron. When the bowel is thus completely stopped, take hold of the silk ligature attached to the sponge, and while with one hand the sponge is pulled *down*, with the other push the wool *up*. This joint action will spread out the bell-shaped sponge like opening an umbrella, and will bring the wool compactly together. This plug may remain in from a week to a fortnight or more. A male catheter passed through the centre of the sponge, with the wool packed around it, is a great improvement, as it enables the patient to pass flatus. Retention of urine will occur after this packing, but may be relieved with a catheter. Stimulants are best withheld until reaction has set in. Opium should always be freely exhibited after the introduction of the plug, as otherwise straining will be set up. As soon as it can be taken, nourishment is to be given, and Liebig's cold soup, which can be quickly prepared, I have found a wonderful restorative. Hot liquids, I need scarcely say, are to be avoided. As soon as a patient can take solid food, he should have it, but it should be nourishing and easy of digestion. The drugs which I prefer are the tinctura ferri perchloridi and the liquor ferri peracetatis, as these are not only hæmostatics but also blood-repairers.

PROCIDENTIA AND PROLAPSUS OF THE RECTUM.

True procidentia is the descent of the upper part of the rectum, in its whole thickness, or all its coats, through the anus. True prolapsus is a descent of the lowest part of the rectum, the mucous membrane and submucous tissue being turned out of the anus. A third variety consists of an intussusception, the upper part of the rectum descending through the lower part. It is easily diagnosed from ordinary procidentia by there being a more or less deep sulcus around the inner column of the intestine; so that there are, as it were, two cylinders of rectum, one inside of the other.

The expression prolapsus ani is often loosely applied to protruding internal hemorrhoids, thus giving rise to unnecessary confusion. Internal hemorrhoids come down as distinct and separate tumors, with a smooth and shiny surface, and are hard to the touch. True prolapsus has no folds, except one towards the perineum (which indeed may be absent), and feels to the finger soft and velvety. But the most common *cause* of prolapsus is undoubtedly the presence of internal hemorrhoids. I have seen it also as the result of straining, in fissure, and in conditions of the urinary tract accompanied by difficulty of micturition, such as urethral stricture, the presence of a stone in the bladder, enlarged prostate, cystitis, etc. In children, diarrhœa, often the result of strumous inflammation of the bowels, worms, and phimosis, are responsible for a great many cases. Polypus may be the cause of either prolapsus, procidentia, or intussusception. It must be well understood that, as procidentia is only a more advanced degree of prolapsus, all the causes above mentioned will, if they act long enough, produce it also. When procidentia occurs conjointly with internal hemorrhoids, removing them by either crushing or ligature will almost certainly cure it.

Procidentia of the rectum is more often seen in children than in adults, although it is by no means a rare affection in women—particularly those who have borne many children—and in men advanced in years. Procidentia in children is much favored by the formation of the pelvis, the sacrum being nearly straight. Moreover, all infants strain violently when their bowels act, even when their motions are quite soft; there appears to be some physiological necessity for this, which I do not pretend to explain or understand. But these facts are not quite sufficient to account for the proneness of children to this malady; there must be, in addition, some inherent weakness or extraneous source of irritation present, by which excessive straining is produced. There are many cases, however, in which we can assign no special cause, where the child is not manifestly unhealthy, and where no source of irritation can be detected. I am sure that the very bad custom of placing a child upon the chamber-utensil, and leaving it there for an indefinite period, as practised by many mothers and nurses, is a fertile cause of procidentia.

In children the treatment is generally successful: it should first be addressed to the removal of any source of irritation; this accomplished, a cure is speedily effected. Where no source of irritation can be discovered, the general health must be attended to. The child should never be allowed to sit and strain at stool; the motions should be passed lying upon the side, at the edge of the bed, or in a standing position, and one buttock should be drawn to one side, so as to tighten the anal orifice while the feces are passing; this device I have found to be very useful. When the bowels have acted, the protruded part ought to be well washed with cold water, and afterwards a solution of alum and oak-bark, or infusion of matico, should be thoroughly applied with a sponge; the bowel must then be returned by gentle pressure, and the child should remain recumbent for some little while, lying upon its face on a couch, before running about. If there be any intestinal irritation, I order small doses of mercury with chalk, and rhubarb, at bedtime, and steel wine two or three times in the day. When the child is very ill-nourished, cod-liver oil does much good; the diet should be nutritious and digestible. If these mild measures do not succeed, I find the application of strong nitric acid the best remedy. The child should be anæsthetized, and the protruded gut well dried. The acid must be applied all over it, care being taken not to touch the verge of the anus or the skin. The part is then to be oiled and returned, and the rectum thoroughly stuffed with wool; a pad must after this be applied outside of the anus, and kept firmly in position by straps of plaster, the buttocks being by the same means brought closely together; if this precaution be not adopted, when the child recovers from the anæsthetic, the straining being urgent, the whole plug will be forced out and the bowel will again protrude. When the pad is properly applied, the straining soon ceases, and the child suffers little or no pain. I always order a mixture of aromatic confection, with a drop or two of tincture of opium, so as to confine the bowels for four days. I then remove the strapping, and give a teaspoonful of castor oil. When the bowels act the plug comes away, and there is no descent of the rectum.

In procidentia in the adult the mass is sometimes very large; I have seen it in a woman larger in circumference than a fœtal head, and seven or eight inches in length. I have had, in my own practice, many cases of procidentia in which there was a hernial sac in the protrusion, and in all it was situated anteriorly, as from the anatomy of the part, of course, it must be; the intestine could be returned from the sac, and it went back with a gurgling noise. As soon as the bowel protrudes, a hernia can be recognized by the fact that the opening of the gut is turned towards the sacrum; when the hernia is reduced, the orifice is immediately restored to its normal position in the axis of the bowel. I have never found such a hernial protrusion in a child.

In very old and bad cases of procidentia, more or less incontinence of feces always exists, owing to loss of tone in the sphincters and loss of sensitiveness in the altered mucous membrane. Thus when fecal matter reaches the lower part of the rectum, the sphincters are not stimulated to action, nor is the patient aware of its presence. The most satisfactory operation for procidentia in the adult with which I am acquainted is that recommended by Van Buren, which I perform as follows:—

The patient is etherized, and the procidentia is drawn fully out of the anus by the volsella; I then make four or more longitudinal stripes, from the base to the apex of the protruded intestine, with the iron cautery at a dull red heat. I take care not to make the cauterization as deep towards the apex as at the base, because near the apex the peritoneum may be close beneath the intestine, while a deep burn near the base is not dangerous. I take care to avoid the large veins which can be seen on the surface of the bowel. If the procidentia is very large, I make even six stripes. I then oil and return the intestine within the anus; having done this, I partially divide the sphincters on both sides of the anus with a sawing motion of the hot iron, and then insert a small portion of oiled wool. From the day of operation I never let the patient get out of bed for anything; the motions are all passed lying down, and consequently the part never comes outside. If the wounds have not all thoroughly healed in a month, I continue the recumbent position for two weeks more, by which time it very rarely happens that cicatrization is not complete. The patient can then arise and get about, but still for some time I enjoin that evacuation of the motions should be accomplished lying down. The reason for the success of the treatment is simple enough. When the burns are all healed, the bowel by contraction of the longitudinal stripes is drawn upwards, and circumferential diminution also takes place. In these cases, before operation, the sphincter muscles have quite lost power, and the anus is large and patulous ; by sawing through the anus with the iron, the muscles contract and regain their power, the patient having strength to cause the anus to close at will, and even to some extent to squeeze the finger when introduced.

Sometimes when a large portion of the bowel comes down, there is much difficulty experienced in returning it. I have found that the passing up the bowel of a large flexible bougie, so as to carry before it the upper part of the descended gut, is of great service ; gentle taxis should at the same time be practised.

A tiresome diarrhœa is very commonly present, and there is often a discharge of mucus which keeps the linen damp and adds not a little to the general discomfort. One teaspoonful of powdered acorns in a tumblerful of milk, every morning, answers better than anything else that I know of, as a remedy for this. The frequent and bountiful application of cold water in these cases is to be most strongly recommended, as it fulfils the same purpose as astringent lotions, and quite as effectually.

Pruritus Ani.

Pruritus ani, or painful itching of the anus, is frequently induced by habits of too free eating and drinking ; it occurs thus in subjects of the lithic-acid diathesis. I am bound to say, however, that there are exceptions to this rule, as I have seen a most ascetic clergyman suffer dreadfully, as well as a lady who had been all her life a total abstainer, and a remarkably small eater. Hepatic affections with constipation, disorders of the stomach, and uterine diseases, are prolific causes of pruritus ani; and gout, especially latent gout with its accompanying eczema, is responsible for a great deal of suffering from this troublesome affection. Amongst local causes, the presence of internal hemorrhoids, vegetable parasites, pediculi, and ascarides, are the most frequent.

Doubtless there are many cases of pruritus for which we are unable to assign any cause, and it may then be considered as a pure neurosis. On examining the part, a distinctly eczematous rash is often seen, which is moist from exudation ; or the anus may be dry and rugose, with bright redness consequent upon scratching ; occasionally there are numerous minute scales to be seen, forming irregular rings ; often there are cracks radiating from the anus and even extending up to the sacrum ; but what I consider the characteristic condition—which may always be noticed when the disease is severe and has lasted for any length of time—is the loss of the natural pigment of the part. To such an extent does this loss often occur, that patches around the anus, extending backwards as far as the sacrum and forwards to the scrotum, are of a dull-white, parchment-like character, and have lost all the normal elasticity of healthy skin.

When considering a case as to the question of *treatment*, it is always important to discover the cause of the irritation. I once had a patient who invariably got an attack of pruritus from eating lobster or crab, and another in whom salmon produced the same effect. There is but little doubt that excesses at table, combined with a want of active exercise, form not only a predisposing but also an exciting cause. Excessive smoking is another excitant of the disorder. When a tendency to the malady exists, over indulgence in smoking may be immediately followed by an attack of pruritus.

The surgeon should investigate closely the habits of his patient, and should recommend a plain, sometimes even a low diet. He should interdict both beer and spirits, and should restrict the drinking to a little light sherry, or to claret and Vichy or Seltzer water. Coffee should be given up, and weak tea substituted.

A walk of three or four miles, at such speed as to induce slight perspiration, should be taken daily, and every morning a sponge-bath is strongly advisable, with, once a week, a warm or, better still, a Turkish bath. The anus and parts around it should be washed every night when retiring to bed with warm water and tar or Castile soap.

The bowels must be well opened daily; the following prescription will be found beneficial: sulphate of magnesium, ℈j; powdered carbonate of magnesium, gr. v; wine of colchicum, ♏ v; syrup of senna, fʒj; compound tincture of cardamom, fʒss; infusion of cinchona, f℥j, twice or thrice in the day; and I also often order two grains of Plummer's pill with three grains of compound rhubarb pill, to be taken every other night for a week. I likewise frequently prescribe the mineral waters of Carlsbad, Friederichshall, Vichy, Hunyadi-Janos, etc.

After washing the parts at night, let the patient apply this lotion on a piece of lint fixed with a T bandage: Sodæ biboratis ʒij; morphiæ hydrochlor. gr. xvj; acidi hydrocyan. dil. f℥ss. The lint may be kept moist with this lotion by dabbing it through the bandage. Calomel ointment and chloroform locally (chloroform. fʒij, glycerinæ f℥ss, ung. sambuci ℥iss), sulphide of calcium internally and externally, liquor carbonis detergens when there is much eczema, and carbolic glycerole, are all admirable remedies, and may well be tried in obstinate cases.

When the surgeon has made up his mind that the disease is a nervous one, as I think it often is in spare and delicate, excitable people, he should give arsenic and quinine freely, and be prepared to push them to their physiological effect, at the same time of course using local means to allay irritation. In obstinate, old-standing cases, I usually commence treatment by rubbing the parts thoroughly with a solution of nitrate of silver, ℈ij to f℥j; this softens the skin, and induces a more healthy action and secretion. The disorder is much more common among men than among women; it is not often met with in young persons. When an attack of pruritus comes on after mental overwork, bromide of potassium is very advantageous. Opium given internally increases the disorder.

I have for years past recommended the introduction into the anus, at bedtime, of a bone plug, shaped like the nipple of an infant's feeding-bottle, with a circular shield to prevent it from slipping into the bowel; the nipple should be about an inch and a half in length, and as thick as the end of the forefinger. I presume that it does good by exercising pressure upon the venous plexus and nerve-filaments close to the anus. At any rate, it stops the itching and insures a good night's rest. I advise it to be worn every other night. Pruritus caused by a vegetable parasite is readily cured by a lotion of sulphurous acid, one part in six.

Polypus of the Rectum.

By the word "polypus" I mean a pedunculated growth attached to the mucous membrane of the rectum, and generally situated not less than an inch from the anus. Polypi may be attached two inches up the bowel, but only occasionally more than that distance.

Polypi have been usually described as of two kinds: the soft or follicular, and the hard or fibrous, the former being found in children and the latter in grown-up persons. I am of opinion, however, that the soft polypus is not always the one found in young children, and consider the true fibrous variety rare even in the adult. In fact, this rough division is very far from expressing the pathological truth, for the true fibrous polypus is in its anatomy an almost perfect counterpart of the fibroid tumor of the uterus, that is, a myoma. The few which I have myself seen have been nearly as large as walnuts; they creak when cut, and the incised surface is of a pale color. The peduncle is about an inch and a half long, and is always attached above the sphincters; the tumors do not usually appear outside of the anus; they do not bleed, but when they protrude they cause pain, irritation, and spasm, and often set up ulceration of the bowel. The discharge from them is of a very ichorous and ill-smelling character.

The polypi usually found in the adult are smaller than the mucous polypi of children; they are multiple. I have often found two growing from opposite sides of the rectum; there may also be two stems with only one head. The pedicle may be an inch or a little more in length, and is not uncommonly hollow; the polypi are neither very hard nor soft, and are easily compressible; they are sometimes cystic; a large vessel runs up the stem, and in some cases can be felt to pulsate. In women rectal polypi are almost always soft, with remarkably long and rather slender stems.

The polypi of children are small, vascular tumors, with peduncles often two inches long. They resemble small, half-ripe mulberries more than anything else. They bleed very freely at times, and occasion in the young great debility. They are said to be hypertrophies either of the glands of Lieberkühn, or of the mucous follicles of the rectum. They may be dangerous when high up, by occasioning intussusception of the bowel, with total obstruction and death. When the peduncle is more than an inch in length they usually protrude at stool, and require to be returned after the bowels are relieved.

The general *symptoms* in children are: frequent desire to go to stool, accompanied by tenesmus; occasional bleeding, with discharge of mucus; and the protrusion from or appearance at the anus of a fleshy mass when the bowels are acting. In the adult, the history of polypus is curious. Without any previous discomfort of any kind, the patient suddenly finds a substance protruding from the anus after going to the closet. This is characteristic of the malady. Until the peduncle becomes long enough to allow the polypus to be extruded and grasped by the sphincter, no inconvenience is felt, and therefore the patient speaks of a sudden onset; this is quite different from the history of hemorrhoids.

In examining a patient, an injection should be administered before introducing the finger; even if the polypus slips away, the surgeon will always be able to feel the pedicle at its point of attachment. The only *treatment* to be recommended is the removal of the growth.

This is best done by seizing the peduncle close to its base with the German catch-forceps, and gently twisting the polypus around until it comes away. There is no danger of hemorrhage, no pain, and scarcely any necessity for resting more than one day. If a ligature is used, the patient should rest until it separates, as otherwise abscesses may follow.

The rarer kinds of polypi are the *dermoid*, the *cystic*, the *sarcomatous*, and the *disseminated*; the latter are *adenoid* as a rule, and the mucous membrane of the rectum and of the colon may be closely studded with them. Another very rare tumor of the rectum is the *villous*. This consists of a lobulated, spongy mass, with long villus-like processes studding its surface; it resembles exactly, though its villi are much larger, the growth of the same name found in the bladder. Usually it has a stem, broad rather than round, which I think is an elongation of the mucous membrane rather than a new formation. These tumors may become malignant. I have seen two cases in which epithelioma replaced the villous growth.

Impaction of Feces.

By this expression is meant an accumulation in the pouch of the rectum, immediately above the internal sphincter. It occurs in females more commonly than in males; old women, and women shortly after their confinements, being especially liable to it. I have seen it in children, and call to mind a little boy, only three years of age, who had a veritable impaction which gave a good deal of trouble; but when it was removed the bowel regained its tone quickly, and regular action was afterwards easily kept up.

The *cause* of the accumulation I believe to be nearly always, primarily, a loss of power in the muscular coat of the rectum. Constipation is its invariable forerunner, and this may be due to spasm of the sphincter. In impaction, sphincter-spasm always exists, so that when the patient strains the anus protrudes like a nipple.

The *symptoms* of impaction may be obscure, and I have known it mistaken for neuralgia of the rectum, gout of the rectum, and malignant disease of the cæcum or sigmoid flexure. I once attended a gentleman who had been believed by his physician to have incipient disease of the brain, so much nervousness and hypochondriasis resulted from a very loaded colon and impacted rectum. In another case, phthisis had been diagnosed by several medical men on account of a constant cough, with hectic at night, and much emaciation. But the most common error is the mistaking of impaction for diarrhœa with tenesmus. In many of these cases the patient complains of a tendency to diarrhœa, liquid motions being frequently passed, especially after taking an aperient, but without any sense of relief; and on assuming the erect position, straining—severe, continuous, and irresistible—takes place. On lying down this generally passes away.

In the history of these cases it is not rare to find that severe pains have been experienced in the right lumbar and left inguinal regions; this symptom points to the fact that the cæcum has been the seat of obstruction and distension, and that when this has been removed, the feces have again lodged in the rectal pouch. Dyspepsia, irritability of temper, nervousness, and despondency—the patient supposing herself to be suffering from an incurable malady—a very muddy, yellow, skin suggestive of malignant disease, morning vomiting, loathing of all food, and excessive thirst, are among the common symptoms of this disorder. A peculiar, ringing cough, particularly in women, and also night-sweats, are not uncommon. In both men and women obstinate retention of urine may be caused by impaction. When examining a patient, tumors may be felt in the cæcum, the transverse colon, or the sigmoid flexure. The anus will be found nipple-shaped, and the sphincter muscle as hard as a piece of wood. On introducing the finger into the bowel (no easy matter), a ball of hardened, clayey feces will be found filling up the rectal pouch. This ball I have seen as large as a fœtal head, and quite movable, so as to admit of liquid or thin fecal matter passing around by its sides, thus giving rise to the impression that diarrhœa rather than constipation existed. So deceptive is the feeling which this mass gives to the fingers, that I have more than once thought that I must be touching a tumor.

In bad cases the sphincters must be dilated under an anæsthetic, and then the mass broken up with the finger or a lithotomy scoop, or the handle of a silver spoon. After having thoroughly disintegrated the impacted mass, injections of soap-suds and oil may be administered to get rid of the enormous quantities of feces that will come down from the colon. It often takes time before the rectum can recover its power after its great distension, and therefore reaccumulation must be guarded against by injecting cold water, kneading the abdomen, and giving nux vomica with decoction of aloes. Exercise in the open air should be taken daily, and the diet should be moderate and simple.

In the diagnosis between impaction and malignant disease, two points are of extreme importance. The first is, that in impaction the tumor differs in size and shape from time to time. The second, that the tumor in impaction has a decidedly doughy feel, and is irregularly soft. When the tumor is in the rectum, the introduction of the finger will at once clear up the doubt, if there be any.

Concretions in the bowel are rarer than impactions. They are usually formed around some foreign body. I have seen a quantity of human hair form the core of a concretion, the patient having swallowed the hair in a fit of mania. Biliary calculi are often found in the centre of these concretions. The strangest case that I have ever seen was one in which a sovereign, swallowed fifteen months before I removed the concretion, was found to be its nucleus. It is curious that large bodies, such as a set of false teeth with gold mounting, may not be arrested anywhere in the intestines, while a small body, such as a sovereign or a date-stone, may fail to traverse the alimentary canal safely, and may indeed set up ulceration of the bowel and perforation.

Neuralgia of the Rectum.

A pain in the rectum or sphincter muscles may be called neuralgia, when not the slightest lesion, sign of inflammation, or discharge of any kind can be discovered, and when the pain is not aggravated by action of the bowels. This last is a most important point in diagnosis. I have more than once considered pains to be neuralgic which I afterwards discovered to originate from a structural lesion. Patients with rectal neuralgia are mostly delicate, irritable or nervous people, who have been subjected to neuralgic pains in other parts. I have noticed the attack to follow direct exposure to wet and cold, by sitting upon damp grass. One attack predisposes to another. Usually in these cases there is general debility with disorder of the digestive organs, mainly the liver.

In *treatment*, the abdominal viscera must be first unloaded and put into condition, and then quinine, iron, strychnia, and hypodermic injections of morphia may at once cure the patient. In some instances, however, treatment only does temporary good, and nothing appears to be of permanent use. When the sphincter is the seat of pain, there is always spasmodic contraction. Dilatation of the anus answers best here, followed by an injection of morphia.

Irritable Rectum.

This I believe to be really the result of a chronic inflammation of the mucous membrane, as it is accompanied by much heat in the bowel, and by tenesmus, as well as by a discharge of mucus. These cases are best treated by the administration of gentle laxatives and of alkalies with bitter infusions, and by insufflation of bismuth and charcoal into the rectum. When the irritability is allayed, injections of rhatany and starch, with small doses of the liquid extract of opium, will render the cure permanent.

[INFLAMMATION OF THE RECTAL POUCHES.

Under the names of *Encysted Rectum* (Physick) and *Sacciform Disease of the Anus* (Gross), has been described an inflamed or ulcerated state of the rectal pouches or lacunæ, which sometimes, particularly in old persons, become enlarged, and serve as receptacles for fecal matter. The *symptoms* of this affection are intense itching and often severe pain, but without spasm of the sphincter. The *diagnosis* may be made by exploring the gut with a bent probe or blunt hook. The *treatment* consists in drawing down the affected pouches and excising with curved scissors the folds of mucous membrane at their base.

RECTO-VESICAL FISTULA.

An abnormal opening between the rectum and bladder may be due to congenital defect,[1] to ulceration, usually malignant in character, or to a wound, as occasionally happens in the operation of lithotomy. As a result, urine escapes into the bowel, and, if the opening be large, fecal matter may enter the bladder, causing great pain and irritation. In some cases, an attempt may be made to close the fistula by the application of caustics or the galvano-cautery, or by a plastic operation analogous to that employed in cases of vesico-vaginal fistula, but in cases of malignant ulceration palliative measures are all that can ordinarily be recommended, though colotomy (preferably by Amussat's method[2]) may be occasionally justifiable.

RECTO-URETHRAL FISTULA will be considered in the article on Injuries and Diseases of the Urethra.]

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[1] See page 99, *supra*.

[2] See page 78, *supra*.

URINARY CALCULUS.

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"To make calculi of uric acid without colloids would be as hopeless a task as making ropes of sea sand." "The pebbles of the concrete would not hold together without the cement to bind them and act on their surface."

The enunciation of this truth, by William M. Ord,[1] marks the starting point of a new era in the scientific study of calculous formation. The experiments leading to these conclusions, begun by Rainey and improved upon by Ord, are the first serious efforts toward a scientific appreciation of the subject of which we have any record.

The beautiful micrographic illustrations of large thin sections of urinary calculi, recently published by Ultzmann,[2] and the accompanying lucid descriptions, seem to establish beyond question that there is a law governing the massive crystallization of the various urinary salts, as uniform in its action as that which regulates the structure of the smallest crystal. Urinary calculus is not an accidental agglomeration of solids, crystalline and amorphous, in a cement of mucus. It is a massive crystallization of urinary ingredients in a colloid, and its formation occurs in obedience to a fixed law. Ultzmann recognizes that there is a law and demonstrates it; but he fails to grasp the idea of the colloids, or to mention their influence. He recognizes only two causes of the crystallization—1, an appropriate chemical condition of the urine; 2, an abnormal condition of the urinary apparatus—notably inability on the part of the bladder to empty itself entirely.

The first appearance of calculous disease cannot be determined, but in the nature of things it must have shown itself, or rather its symptoms must have appeared, soon after the earth was peopled, unless prostatic enlargement is a malady of modern times, which there is no reason to believe.[3]

Certain it is that an authentic record of stone exists in a medical treatise, called *Suçruta*, a Hindoo work, believed by some authorities to antedate the Hippocratic collection. In this work, which was published in Sanscrit, at Calcutta, in 1835, and afterwards translated into Latin by F. Hessler, a very fair description of cutting for stone "upon the gripe" is given, the method now commonly known as the method of Celsus. It seems doubtful whether the Hindóo method of extracting stone described in the *Suçruta*, was practised by physicians, or only by certain travelling specialists, as was the case in Greece.

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[1] The Influence of Colloids upon Crystalline Form and Cohesion, p. 61. London, 1879.

[2] Die Harnconcretionen. 1882.

[3] Probably the most masterly treatise upon the history of stone which has been written, is Bégin's edition of the Traité historique et dogmatique de l'Operation de la Taille, by Deschamps, which appeared in Paris in 1796.

The Chinese are believed to have been acquainted with stone long before the modern era, and Albucasis, among the Arabians, certainly performed lithotomy.

Hippocrates was familiar with the existence of stone. He used sounds and catheters habitually, and described the use of instruments for the detection of stone. But the mortality attending the operations of peripatetic lithotomists was so great that wounds of the bladder came to be looked upon as necessarily mortal, and Hippocrates could not countenance the practice of lithotomy.

In spite of his conservative opposition the operation flourished, however, and Celsus tells how Ammonius of Alexandria, in the third century before our era, proposed that, after the soft parts had been divided, the stone should be cut by an instrument of his invention, if it should prove too large for extraction without injury to the neck of the bladder. From this circumstance, lithotomy takes its name.

Celsus wrote in the first century before our era, and the method of his day, cutting on the gripe, is now often spoken of as his.

The chemical side of the study of stone includes many distinguished names—among them notably Van Swieten, Van Helmont, Scheele, who discovered uric acid in 1776, Bergman, who detected lime in calculi, Wollaston, who discovered, or rather gave a fixed character to, the fusible, the mulberry, and the pure earthy-phosphatic calculus. All of these varieties were described accurately by him in 1797, and he afterwards added cystic oxide to the list. Fourcroy and Vauquelin announced soon after that they had detected urate of ammonium and silica in calculi, and a host of modern investigators in urinary physiology and pathology have helped to make our knowledge of the chemical and microscopical nature of calculous concretions very exact.

Urinary calculus is a term applied to a concretion of more or less stony hardness found at any point along the urinary tract or in a fistula communicating with that tract. The calculus may be formed of crystalline organic matter, of earthy phosphates, of fibrin, of indigo, or of other substance.

It may form spontaneously, or upon a nucleus introduced from without. It may be microscopic in size, or as large as a child's head at term. A minute rounded concretion, smaller than a millet-seed, may properly be called a stone if it shows a laminated structure under the microscope; while clusters of large size composed of a conglomeration of crystals, separate crystals, and sand, may, whatever their size, be properly termed gravel.

This distinction has practical value in connection with the questions of prognosis and of the preventive treatment of stone. In these respects, if the careful scientific researches of Rainey, Ord, and Carter have any value, the distinction is important. For inasmuch as the salts of the urine assume a solid state in the crystalloidal, or in the colloidal form (submorphous of Carter), we have the element upon which to decide, in a given case, whether the tendency to stone formation is great or small. The crystalloidal forms may be somewhat disregarded; the colloidal call for earnest consideration.

Crystals under ordinary conditions in the urine do not unite to form a stone. Something more is necessary. Earthy phosphates also fail to form stone under ordinary conditions. Thompson has called special attention to this, and it has long been a well-known fact that a patient with the so-called phosphatic diathesis may habitually urinate in such a way that the latter part or the whole of his stream of urine is creamy-white with precipitated earthy phosphates, and yet will never have a stone as long as the mucous membrane of the urinary tract remains free from inflammation.

On this point Ultzmann[1] does not agree with Thompson, but holds that extreme phosphaturia is a factor in phosphatic stone formation. While this may be true in those occasional cases of alkaline stone which contain no ammonia (the pure phosphate-of-lime and carbonate-of-lime stones), it certainly does not hold good for ordinary phosphatic stones—triple-phosphate and fusible calculus—the only true secondary stones. In the formation of these latter, inflammation of the mucous membrane of the urinary tract has always been an etiological factor; and it makes no difference whether the urine has been customarily acid or alkaline, such an inflammation with obstruction to the free escape of urine is efficient to produce an ordinary phosphatic stone.

Other individuals again, at intervals, pass red sand of crystallized uric acid with great freedom, but do not on that account alone necessarily get stone in the bladder.

The element most essential for stone structure is the skeleton of the stone—not so much the solid as the soft part—the colloids, the glue, by which the solid elements are collected and fixed.

Geographical Distribution of Stone.

It is well known that stone occurs much more frequently in certain districts than in others, but a satisfactory explanation of this fact has not yet been given. The use of hard water for drinking does not explain the matter. Agnew[2] says that in certain valleys in Lancaster County, Pennsylvania, of limestone formation, the water is very hard, being strongly impregnated with lime, and yet calculus is uncommon; and he joins former writers in the very apposite reflection that it is difficult to understand how calculi—most of which are composed of uric acid—could be formed out of lime. Civiale, whose statistical researches were very thorough, has written:[3]—

> Dr. Warren, of Boston, has recently told me that stone is very rare in Massachusetts, and is almost unknown in those localities where granite rock abounds, while it is found occasionally at other points where the soil is calcareous; but this alleged influence of the nature of the soil upon the production of the calculous disorder is an hypothesis only admitted in order to explain facts, the true cause of which is not evident. Several of the localities from which I have received statistical documents possess the granite formation, but in spite of this, calculus is far from being a rare disorder.

Again, speaking of the stone cases reported from the department of Var, in France, he says:—

> The malady seems to be equally divided among all classes of society; the nature of the soil, which is of flint and granite on the coast, and calcareous in the interior, does not appear to make any sensible difference in the distribution of cases.

Cadge,[4] of Norwich, England, on the other hand, ascribes the great frequency of calculous (uric-acid) disorder in that district to the hardness of the water, and Prout shares his opinion. Reginald Harrison[5] tries to establish a connection on the ground that hard waters interfere with digestion, and in this way modify the conditions of the solids and colloids in the urine. He mentions the frequency of stone in the young among the poor about Norwich, and the fact that milk is scarce and dear, and quotes Cadge's assertion that the frequency of stone in children will be found in strict accordance with the difficulty of procuring milk.

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[1] Op. cit., S. 30.

[2] Principles and Practice of Surgery, vol. ii. p. 631.

[3] Traité de l'Affection Calculeuse, p. 588. Paris, 1838.

[4] Brit. Med. Journal, vol. ii. pp. 207–212. 1874.

[5] Lectures on the Surgical Disorders of the Urinary Organs, 2d ed., p. 245. 1880.

Mastin[1] takes the other side, showing that in Kentucky and Tennessee—sandstone districts where the water is very soft—calculous disorders are common, and are just as frequently encountered as in the limestone areas of the same region, where hard water is drunk. No country is exempt from calculous disorder, yet the areas of its prevalence are small. Thus in England, the eastern counties, Norfolk and Suffolk, appear to be most afflicted. It is noteworthy that as many cases occur each year in Norfolk, among its 438,656 inhabitants (Cadge), as in all Ireland with a population of 5,412,377. The northern counties of Ireland and of Scotland furnish more cases than the remaining portions of those countries.

Calculous disease abounds in France, in Teneriffe, in Iceland, and in Egypt. Its frequency in Egypt is said by Roberts[2] to be due to the presence of the minute urinary parasite, the Bilharzia hæmatobia. Stone is also very common in Russia, especially in the central parts of European Russia. Klein[3] states that cases of stone sometimes constitute a fifth of all those under treatment in the hospitals of Moscow. Estlander,[4] on the other hand, shows that primary calculus is almost unknown in Finland, the University Hospital case-books showing only one Finlander with uric-acid stone during a period of forty-four years. There were cases of phosphatic stone with paralyzed bladders, etc.

Civiale[5] notices a similar immunity in Christiania, where out of 3211 patients in hospital during four years only one had stone, while in the hospital at Gothenburg, in Sweden, a hospital of sixty beds, there had been no stone case in fifty years.

Fayrer[6] says that stone is very common in the northwestern and central provinces of India, 554 cases having been cut for stone during a single six months in 1863. In Lower Bengal it is rare. Fayrer[7] says that lithotomy has been performed only about one hundred times in the Medical College Hospital of Calcutta. Harris confirms the fact, and ascribes the frequency of the malady in the Northwestern Provinces to the prevalence of cold winds from the Himalayas, and to the use of a heavy unfermented bread by the natives. Dr. Garden's[8] testimony from the Sarahunpore Dispensary is corroborative of the frequency of stone in India. Mastin[9] refers to Curran for authority in stating that Hindostan is exceptionally rich in stone cases. Vandyke Carter[10] speaks for Bombay and the great prevalence of oxalate-of-lime calculi there. He thinks that stone is more common in Western India than in the southern portion.

Mr. Dudgeon,[11] of Pekin, informs us that at Canton, in China, and at Takow, in Formosa, calculus is found, but apparently not elsewhere. At Pekin the water is full of lime, at Canton very soft. Kerr[12] also says that Canton furnishes the stone cases of China, and that not a single case was observed among the thousands of patients treated in the missionary hospitals at Hing-po, Shanghai, Pekin, and Hangkow.

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[1] Causes and Geographical Distribution of Calculous Diseases. Trans. International Medical Congress, p. 609. Philadelphia, 1877.

[2] Urinary and Renal Diseases. 2d American ed., p. 275. 1872.

[3] Ueber Steinkranheit und ihre Behandlung. Archiv f. klin. Chir., Bd. vi. S. 78.

[4] Trans. International Med. Congress, p. 663. Philadelphia, 1877.

[5] Op. cit., p. 580.

[6] Referred to by Coulson (Dis. of Bladder and Prostate, 6th ed., p. 378).

[7] Clinical and Pathological Observations in India, p. 385. 1873.

[8] Indian Annals of Med. Science, 1868, No. 23, p. 20.

[9] Loc. cit., p. 618.

[10] Calculous Disease in Bombay. St. George's Hospital Reports, 1871–2, p. 85.

[11] Calculus in China. Med. Times and Gazette, Sept. 2, 1876. p. 252.

[12] New York Med. Journal, 1871.

In Norway, Sweden, Denmark, Styria, and Spain, stone is not very common. In France and Holland it is abundant; in Austria, Germany, Italy, Syria, and Persia, it is reasonably frequent. In Mexico, Central and South America, and Australia, as far as known, the disease is not common.

Livingstone failed to find syphilis or stone among the natives of Central Africa.

In North America, in the United States, the greatest number of stone cases originate in the central districts—Tennessee, Kentucky, Ohio, Indiana, Missouri, Western Pennsylvania, and Virginia. In Utah it is said to be common. Authorities differ as to Georgia and North Carolina. In the Northern, Eastern, the Gulf, Southern, and Western States calculus is uncommon, as it is also in the Canadas and British possessions. These peculiarities of distribution are not satisfactorily accounted for by any peculiarities of water, food, or climate.

Causes of Stone Formation.

First among the causes of stone formation, according to the best modern investigation, must be placed the influence of the colloids. Doubtless such substances as disturb digestion and nerve-force, and furnish an excess of uric acid, of oxalate of lime, of phosphates, as the case may be, favor the formation of stone, but alone they are not sufficient. Undoubtedly also without cystic oxide, urostealith, or indigo, in the urine, calculi formed of these ingredients could not occur. But the fact remains that urates and uric acid may be in excess in the urine for years, and phosphates for a life-time, and no concretions into stone take place, while at a given moment, presumably during a proper co-operation on the part of the colloids, primary (acid) stone starts into existence; or the presence of a foreign body with inflammation of the mucous membrane will speedily give rise to a secondary (alkaline phosphatic) stone in any individual, whether his diathesis be phosphatic or not. The colloid in the latter case is the alkaline muco-pus furnished by the inflamed mucous membrane.

In 1857, George Rainey first showed at St. Thomas's Hospital that certain crystalline materials assumed globular forms when precipitated in gummy solutions, and he announced his mature doctrine of "molecular coalescence and molecular disintegration" in a short treatise published in 1858, "on the mode of formation of shells of animals, etc." His researches led him to conclude that a law existed by which organized bodies assumed a rounded form on account of physical and not on account of vital agencies. The following was Mr. Rainey's process: a solution of gum arabic saturated with carbonate of potassium, sp. gr. 1.4068, perfectly clear, was placed in a bottle, filling it one third, and two clean slips of glass were introduced into the liquid, touching above, separated below. The bottle was then filled carefully with a perfectly clear solution of gum, sp. gr. 1.0844, and set aside for a month.

In this way Mr. Rainey succeeded in forming perfect spheres of carbonate of lime having all the hardness of pearls, and he demonstrated that they were built up by the slow coalescence of minute molecules.

The spheres showed radial and concentric markings, and a very distinct cross in polarized light. Where too spheres touched, they gradually coalesced into one perfect sphere, and where each sphere came into contact with the glass, a shallow pit formed in the latter, due to a new arrangement of its molecules.

Mr. Rainey concluded that the "viscosity" of the gum destroyed the polarity of the crystal which would otherwise form, and that the molecules simply obeyed the law of mutual attraction. The gum was intermixed with the lime in the spheres.

When spheres so formed are placed in new solutions of gum of different specific gravity, they lose their laminated arrangement, split radially, and return to the molecular condition, a process termed by Mr. Rainey "molecular disintegration." This splitting of a concretion in a fluid of different specific gravity from that in which it was formed, is beautifully illustrative of what sometimes takes place in the human bladder in the spontaneous fracture of stone.

Rainey obtained similar results by the use of the carbonates of barium and strontium.

Professor Harting, of Utrecht, in 1872, published some original work in the same direction. William M. Ord has followed up Rainey's investigations with some excellent independent researches directed mainly toward investigating the method of formation of urinary and other calculi, publishing the final results of his labors in 1879.[1] Professor F. Guthrie, and Drs. Montgomery, Jevons, Ascherson, and others, have labored in the same field.

Dr. Ord's second proposition is the following:—

> "A crystalloid is deposited from solution in the presence of a colloid. This occurs in . . . . uric acid and urates mixed with albumen and mucus, in nitrate of urea crystallized from albuminous urine."

The third proposition is—in part:—

> "Crystals are broken down and turned into spheres or spheroids, or molecules, by the action of colloids into which they are introduced," etc.

Uric acid exists in three forms:—

1. Rectangular, oblong, colorless plates—pure uric acid.
2. Rhombohedra and its modifications—urinary uric acid.
3. Spherical form—calculous uric acid.

Ord states that No. 1 is the proper crystalline form of uric acid, and that the changes in form which the urinary crystals present (40–50 varieties) are assumed in obedience to Rainey's law of molecular coalescence, and vary with the quantity and quality of colloidal substances which the urine contains. The pure tendency to polarity in the crystals is modified, and mutual attraction of the particles tends to produce curved lines in the crystalline form.

Four substances in normal urine influence the form of crystals: mucus, urea, extractive coloring matter, and salts. To these must be added the ingredients of pathological urine capable of modifying crystalline form: albumen, sugar, blood, and pus. To mucus and purulent mucus seems largely due the rounded form which uric acid assumes, so that by proper experiments Ord was enabled to form small uric acid calculi under his very eye, as it were. Heat intensifies the action of a colloid, and a colloid in partial degeneration seems to be particularly active. Such a colloid is purulent mucus.

> "Therefore," says Ord,[2] "if the causes of the varying prevalence of calculous disease in different communities and regions are to be fully and usefully examined, such subjects as constitutional proneness or indisposition to vesical catarrh, habits of life, diet, and regimen, or local conditions of soil, water, and climate, which can hinder or promote the secretion of mucus or the occurrence of irritation in the urinary tract, must be carefully treated. And if such observations be applied to practice, we may hope to find

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[1] The Influence of Colloids upon Crystalline Form and Cohesion. London, 1879.

[2] Op. cit., p. 61.

that the prevention of stone becomes partly possible through the prevention of the local conditions which constitute the soil in which it is sown and grows."

Ord states that two-thirds of all calculi "are in bulk composed of, or start from, concretions of uric acid." His experiments with colloids and oxalate of lime lead him to believe that to mould oxalate of lime into calculi requires a denser colloid than usually exists in vesical urine. He therefore believes that the beginnings of oxalic calculi usually occur "in the recesses of the kidney among less diluted colloids."

H. Vandyke Carter[1] believes that it is during some febrile condition, or in connection with some irritation along the urinary tract, that calculi originate; the colloid, mucus, pus, albumen, fibrin, and blood being present coincidently with an excess of the saline ingredient out of which the nucleus is to be composed. He says:—

> "I have noticed in the interstices of a nucleus, composed of oxalate-of-lime spheroids and blood, isolated collections of rhomb-crystals, such as experiment shows will appear in a firm colloid in which oxalic acid and lime are caused to meet, and I venture to suppose that in this case a small mass of mucus served as the medium." In his microscopic researches Carter has found that "calculi are habitually surrounded by a thin layer of mucus in which goes on the process of molecular coalescence resulting in the addition of fresh layers."[2]

Richness of the Urine in Solid Ingredients.—Excess of solids alone in the urine does not necessarily give rise to stone. Ultzmann[3] gives nearly the whole credit in calculous formation to the amount of solids in the urine, notably uric acid. In his investigations he found that about 94 per cent. of all stones had nuclei of uric acid. The element, he believes, which influences stone formation, is the shape of the uric acid crystals. This he found to be modified by the degree of acidity of the solution in which the crystals were deposited, and consequently he assumes that the fan-shaped, sheaf-like masses of pointed, acicular crystals, are the obvious starting points of stone. This assumption is in direct opposition to the conclusions adopted by Ord after the demonstration of experiment.

Ebstein[4] gives clinical strength to Ord's theories in quoting Frerichs as finding in the tubules of the adult kidney, glomerules of urate of sodium, and in a case of Bright's disease amorphous fibrinous coagula with nodules of brown uric-acid crystals the size of a pin's head—evidently rounded by the colloid, and not sheaf-like. Rounded concretions of uric acid of varying size are not infrequently found in diseased kidneys, in cysts and dilated urinary tubules.

That an excess of uric acid in the urine is the chief cause of stone in infantile life, is doubtless true. The uric-acid infarction of Virchow is a phenomenon nearly constant in the kidneys of young infants. It has been found in infants who have never breathed, but is often absent in such cases, while it is most frequently met with in the kidneys of infants who have lived several days.[5] These long lines of reddish gritty substance in the kidney-tubules are believed by Ultzmann to be composed in part of urate of ammonium, and in part of urate of sodium. This statement of their exact nature is not uniformly accepted, but all agree that uric acid is a main ingredient in the infarctions, which occupy the straight urinary tubules, filling them up and giving the pyramids an appearance as if they had been injected.

Ultzmann examined the brown dust passed out from these infarctions upon the infant's napkins with a No. 10 Hartnack immersion lens, and found them to be composed of masses spherical and dumb-bell in shape. Concentrated urine (as that of intra-uterine life always is), and concentrated colloids (those found in the recesses of the kidney tubules), thus seem to give a rounded (colloidal) shape instead of crystalline forms. It is noteworthy that this brown dust is found more often on the napkins of puny infants than upon those of robust babies.

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[1] The Microscopic Structure and Mode of Formation of Urinary Calculi. London, 1873.

[2] Op. cit., page 40.

[3] Ueber Harnsteinbildung. Wiener Klinik, 1875.

[4] Ziemssen's Handbuch d. spec. Pathologie und Therapie, Bd. ix. H. 2, S. 208.

[5] Ebstein, loc. cit., S. 216.

In examining specimens of kidney-substance after putrefaction had begun, large spherical globules were found in great abundance. Ultzmann does not mention colloids, but his testimony goes largely to sustain the assertions of Ord and Carter. His most recent conclusion is[1] that uric-acid infarctions in the kidneys of the newly born are composed of balls or concentrated groups of fine needles of urate of sodium, which would go to prove that in this sense he is correct in believing that the pointed crystal favors calculous formation.

Uric acid is normally present in all urine to the amount of about 10 grains daily. In the natural condition it is not free, but is in combination with alkaline bases which feebly hold it in solution. Any excess of acid of any other kind, such as the acid phosphate of sodium or (out of the body) lactic acid, from acid fermentation of the urine, combines with the bases of urinary salts, and liberates uric acid.

If now crystallization takes place in presence of the feeble and dilute colloids of the bladder, the crystals assume acicular or rhomboid forms, and are passed as gravel. If, on the contrary, the acid crystallizes in the thicker mucous colloid of the kidney-tubules, it may take the laminated form, and is, from its very origin, a stone ready to gather about itself a film of fresh colloid from the mucous membrane of the urinary tract wherever it may lie, the colloid being furnished by the irritation which the presence of the stone occasions, and ever ready in this film of colloid to attract by molecular coalescence fresh particles of uric acid out of the urine. Finally, the stone may excite inflammation of the mucous membrane, cause an outpouring of stringy mucus, decomposition of urine, and precipitation of phosphates, and then its film of colloid becomes a nidus for the deposit of phosphatic accretions, and secondary or alkaline stone formation goes on.

Oxalate of lime in the same way, when in excess, from the food, or from nervous or other causes, may crystallize in its customary octohedral form, or in the modifying presence of a colloid of mucus, blood, or pus, may assume the dangerous dumb-bell or the spherical shape, and may become at once a possible stone. And so of other substances. The phosphates notably do not precipitate in a shape capable of forming stone, except in the presence of the colloid mucopus coming from catarrhal inflammation. Even a foreign body, if unirritating, may remain in the bladder for a considerable period, and no phosphates will precipitate upon it unless catarrhal inflammation be present.

If a small, smooth nucleus gets into a healthy bladder, it may at first excite only enough irritation to surround itself with a film of mucus, in which acid stone formation goes on indefinitely, until the presence of the foreign body excites vesical catarrh, when peripheral deposits of phosphates will take place.

Effect of Age in Causing Stone Formation.—No period of life is exempt from the liability to stone. I have removed, by lithotomy (successfully), from the bladder of a boy of nine, three calculi, weighing collectively very nearly two ounces, which, according to the statement of the mother, had been diagnosticated at the birth of the child. Many operators have reported cases observed shortly after birth. J. W. Troizki[1] extracted from the urethra of a male infant, one month old, a uric-acid stone weighing twenty-five centigrammes, eight mm. long, and five mm. broad. This had formed during intra-uterine life, and had produced acute symptoms when the child was eight days old.

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[1] Op. cit., S. 25.

Civiale never saw a case of congenital stone, but he quotes from Brendel that of a child dying two days after birth, in whose bladder a stone of some size was found, and he alludes to two male babies in whom urethral stone was found within twenty-four hours after birth. A. Jacobi[2] says that he has detected "six cases of congenital renal calculi in forty autopsies," and believes so-called intestinal colic in children to be often renal colic. Langenbeck has settled the whole question of intra-uterine stone by discovering a calculus in the bladder of a male fœtus of six months. This he reported orally to Mr. Coulson. Nearly all surgeons who have dealt with stone, report a greater number of operations upon children than upon adults, and it has been generally admitted that calculus is more common in early than in advanced life. The conditions appropriate for prompt stone formation, as has been shown in connection with the question of the influence of colloids, are amply furnished by the infant, and but for the fact which Coulson has emphasized, that the relative number of young people in the world is so large when compared with the number of adults, it would be fair to conclude that stone was very common in children. This, however, is not strictly true.

Coulson[3] has shown by calculations based upon the statistics of Civiale, that the liability to stone, at the different ages of life, when corrected by taking into consideration the number of people alive at different ages, is very different from the apparent liability computed by simply noting the number of cases occurring at different ages.

Thus, while out of a collection of 5376 cases, 2989 were found in persons under 20 years of age, the number of persons living and under 20 years, in a given 100, is 46; so that while the actual liability appears to be 55 per cent., the real liability is below 25 per cent. In the same way, from 20 to 40, the liability is less than half what it is below 20; from 40 to 60, it nearly reaches the liability of youth; while after 60 it is relatively nearly twice as great as it is below 20.

Thus it will be seen that, according to reported statistics, stone is relatively more common after 60 than before 20, and that the period of early manhood is most exempt. This is undoubtedly due to the facts that all infants who have stone are operated upon or die before 20, and that, activity of life and freedom from debilitating agencies prevailing as a rule between 20 and 50, stone does not tend to form readily at this period.

The few who survive 60 are usually more or less feeble; prostatic disease exists in about one-third of the men, and the conditions favoring secondary phosphatic stone are active. If primary (acid) stones were alone computed, the percentage of young persons affected would easily surpass all others.

Gross and Cadge have both called attention to the fact that in some districts stone seems to be more common in children; in other sections in adults; and Thompson is very positive in stating that while among the poor of London the children furnish many cases of acid stone, the old men of the same class of life do not have phosphatic stone.

WATER AS INFLUENCING STONE FORMATION.—The water question has been already discussed in connection with the geographical distribution of stone.

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[1] Quoted in Centralblatt f. Chirurgie, No. 47, 1881, S. 751.

[2] New York Med. Journal, July 21, 1883, p. 74.

[3] Diseases of the Bladder and Prostate, 6th ed., p. 369. 1881.

One curious means by which water may prove indirectly to be a source of stone formation, is suggested by a recent contribution on the formation of calculi, by Zancarol,[1] surgeon to the Greek Hospital at Alexandria, Egypt. He says that the natives drink unfiltered Nile water, and imbibe the distoma hematobium, and that the animal and its ova can always be found in the urine and among the layers of stone in the case of the natives, who suffer frequently from calculous disorder. The foreigners, who only drink filtered Nile water, do not often have stone, and their urine does not contain the distoma or its ova.

SEX has undoubtedly an influence upon the frequency of vesical, but not of renal, calculus. Absence of the prostate, the large size and shortness of the female urethra, and the comparative freedom of women from urethral diseases and vesical catarrh, are sufficient almost to secure them immunity. Coulson estimates the relative frequency of stone in females as compared with males at 5 per cent. Prout makes it about the same. Klein, in Russia, puts it at a little over one-fifth of one per cent. Secondary phosphatic stones forming upon foreign bodies introduced from without, seem to be, relatively to the whole number of cases, more common in the female than in the male.

RACE seems to influence stone formation. Gross,[2] analyzing the lithotomies reported in some of our Southern States, found the proportion to be one in a negro to six in whites. Rayer says that the negro escapes in Egypt, while the Arab suffers. Mastin[3] collected 3039 lithotomies in America, and found only 102 put down to the negro, and 31 to the mulatto. Mastin says that gout is seldom if ever seen among the black people of the United States, and he quotes Winterbottom as vouching for the same fact in regard to the native Africans around Sierra Leone.

CLIMATE.—Statistics indicate that climate alone does not influence stone formation. Temperate zones seem to be most afflicted, yet the cold winds of the Himalayas, and the gales at Norwich, have been accused of contributing to the calculous tendencies of those regions. The central districts of the United States, however, are not especially windy ; in France, Civiale found the proportion of cases in the Var district the same inland and on the coast. The New England coast is subject to dampness and boisterous northeasterly gales, yet stone is infrequent there.

SOCIAL CONDITION, HABITS, AND OCCUPATION.—These are not prominent etiological factors of stone. Civiale affirms this for France. Soldiers and sailors are reported by all who have given attention to their statistics to be remarkably free from stone, but most soldiers and sailors are between the ages of 20 and 40, and in good general health. Undoubtedly there are more stone cases among the poor than among the wealthy, but the latter class is comparatively small, and nearly all cases of the poor go to hospitals for operation, where they are sure to be recorded, while the wealthy escape tabulation to a certain extent.

In New York there is very little tendency to stone formation. During fourteen years' active surgical work in two of the largest city hospitals (Charity and Bellevue), I have found in my service only two cases of stone. The cases which I have operated upon in hospital have been sent in by myself. Most of my operations have been done in private life.

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[1] Rev. de Chir., 10 Août, 1882, p. 645.

[2] Op. cit., p. 168.

[3] Loc. cit., p. 618.

Thompson[1] however "does does know any disease which marks more distinctly or more curiously, its relation with class than this. So common is stone in the children of the poor, comparatively speaking, that at Guy's Hospital, surrounded as it is by a very large neighborhood, densely populated by some of the worst-nourished classes of the community, quite one-half the cases admitted are children. Among the same classes, however, it is rare at the other end of life, very few elderly working men in London being afflicted with it. On the other hand, among the well-to-do and well-fed, while almost never found in childhood, it is comparatively common in advanced age."

Exercise and fresh air militate against stone formation by thoroughly oxidizing the waste products of the body.

Drink and Food.—*Alcohol* probably will not produce stone without the co-operation of other predisposing agencies. In large cities all over the world, alcohol is consumed freely, but no statistician has ever noted a special prevalence of stone among dwellers in cities. Much liquor is consumed in Scotland and in Ireland, doubtless as much or more than in England, yet the latter locality is the favorite for stone. Some wines, like the Rhine wines (Sœmmering), being charged with bitartrate of potassium, rather check tendencies to stone, but sweet fermented wines and malt liquors, which increase the amount of uric acid, undoubtedly favor the formation of acid stone.

Food alone cannot materially affect stone formation by its quality. Where the tendency exists, it may be intensified by the nature of the food. Thus in India, Vandyke Carter found oxalate-of-lime nuclei most common in the calculi of the rice-eating natives. But it is not starch as food that causes stone, or the potato-eating Irishman would be prone to stone, which is not the case. Nor is it rice-starch, or the Chinaman would be as constant a stone-producer as the Indian—which again is not the case. In Europe and America, uric-acid stones are the rule, but if a meat diet caused stones, the latter would be much more common in cities, where much meat is consumed, than in the surrounding country where the farmers feed more sparingly on meat—but this again has not been noticed as a fact.

Milk diet has been supposed to oppose the tendency to stone; probably this is true, but it is a minor factor. Indigestion again has been accused of causing stone; but if this were so, surely the disease ought to prevail in New England, where bad teeth and dyspepsia, due to hot bread, pie, and rapid eating, are the rule, and yet where stone is very rare.

Constitution.—It is probable that gout and rheumatism increase any tendency which there may be to stone, because these diathetic conditions are usually accompanied by acidity of the urine, with excess of uric acid and urates. A gouty individual leading a sedentary life, drinking freely, and eating highly nitrogenized food, especially if he has a little dyspepsia, and is constantly kept anxious about his business or other matters, is in a fit condition to form stone easily. Such patients not uncommonly pass small uric-acid concretions.

Acute Maladies.—Prout, Kletzinsky, and Beale have pointed out the tendency to a deposit of oxalate of lime in cholera patients. Any feverish condition furnishes in the accompanying concentration of the urine one of the factors of stone, and some authorities believe that all renal stones have their origin during a febrile state, perhaps of short duration.

Heredity.—As gout is hereditary, so are the tendencies to stone. I have at present under observation a family in which three generations, all living, have strong and constantly out-cropping tendencies to the appearance of fine uric-acid gravel. The baby of three years and the grandfather of seventy manifest it about equally.

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[1] Clinical Lectures on Disease qf the Urinary Organs, 6th ed., p. 67. 1882.

The most celebrated recorded instance of inherited tendency to stone is that reported by Mr. Clubbe,[1] of Lowestoft, where six children all had stone, the father and mother passed quantities of uric acid, and the grandfather, grandmother, great uncle, six uncles, four aunts, and a cousin—all had had attacks of gravel, or had been cut for stone. Cadge[2] recently reported a case of stone in a female with sacculated bladder, who asserted that her father had died after lithotrity, and that her brother was then suffering from stone. In several of my own calculous cases the patients, without prompting, have accounted for their stones on the ground that their fathers had had gravel.

It seems to me more than probable that hereditary tendency to stone lies at the bottom of its regional distribution, and accounts for its geographical peculiarities. Generation after generation, growing up in the same region, and intermarrying, would naturally reproduce and intensify any such physical trait. In former years, when locomotion was slow, the few who emigrated married others with different tendencies, and so failed to spread the habit, while those who married others with like tendencies established new areas of stone formation. Food, drink, and surroundings may have intensified or modified these natural physical peculiarities, but that the essence of the geographical distribution of stone (primary, acid stone) lies in intensified hereditary predisposition, seems to me at least plausible in lack of a better explanation. With modern facility and cheapness of locomotion, it seems at least possible that the centres of stone formation may finally be broken up, and that by more general and mixed marriages the disease may become more extended in geographical area, but less active.

CHRONIC DISEASE OF THE URINARY PASSAGES is unquestionably a factor in stone formation. *Stricture of the urethra*, although occasionally complicated by stone, is only so as an exception. Stricture provokes powerful contractions of the bladder to expel its contents. As a rule, the bladder empties itself, and there is generally no physical reason why stone should form. I have encountered stone as a complication of stricture in only three or four instances. *Enlarged prostate*, on the other hand, leads to eccentric hypertrophy and atony. In this condition the patient has residual urine, often in a state of partial decomposition from vesical catarrh, and thus all the conditions necessary for active, secondary, phosphatic stone are present. These conditions exist the world over, and sufficiently explain the great relative frequency of stone in the aged. No case of prostatic disease is fairly treated unless an exploration for stone is made, whether the patient presents any symptoms of stone or not. Diseases of the spinal cord which cause paralysis or atony of the bladder lead to stone (phosphatic), unless the bladder is kept washed out.

FOREIGN BODIES play a chief part in the formation of secondary (phosphatic) stones. The irritation of the foreign body excites more or less catarrh; the urine becomes alkaline, ammoniacal, and partly decomposed; earthy and triple-phosphates are thrown down; and in the colloid muco-pus about the foreign body the phosphatic material stiffens into stone.

A foreign body never becomes encased with phosphatic material until after it has excited catarrhal inflammation of the mucous membrane upon which it rests. The same statement applies to any foreign body anywhere in the urinary tract, be it a blood-clot, the ovum of a parasite, a tooth, piece of bone, or bunch of hair from an ovarian cyst, a bullet from without, a piece of broken bougie, or any substance introduced by accident or design. Any calculous nucleus coming down from the kidney is as much a foreign body as if it had been introduced through the urethra, and is built upon by the same laws, by acid layers first, and then, after catarrh, by phosphatic layers.

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[1] Hereditariness of Stone. Lancet, Feb. 10, 1872, p. 204.

[2] Lancet, January 5, 1884, p. 6.

Classification of Urinary Calculi.

Calculi as commonly encountered are made up of several ingredients, one of which is always animal matter, a sort of stroma that pervades the mass in which the other materials, crystalline and amorphous, are deposited. The cement-substance is constant and probably uniform in character. Different opinions are held concerning its exact nature. It contains mucus, fibrin, and albumen, but the final word has not been spoken as to its exact composition. Certain microscopic fungous spores and mycelium have also been found and described as part of the organic composition of a stone, but their presence seems purely accidental. The other ingredients which the cement substance holds together are not usually uniform in character—urates, uric acid, and oxalates occurring together in the same stone, and phosphates being perhaps added on the outside.

The nucleus of a stone often differs in composition from the various superimposed layers, but the name of the stone surgically depends upon that ingredient which constitutes most of its bulk. The nucleus and the organic stroma are disregarded. An oxalate-of-lime nucleus in a large concretion of uric acid, surrounded by a thin layer of phosphates, in a surgical sense is a uric-acid stone.

Scientifically this is not accurate, for a calculus owes its existence to its nucleus, and it would be more exact to name the stone according to that nucleus if its composition could be readily determined; and in a certain practical sense also a stone might take its name from its nucleus, because only by determining the character of that nucleus can the special tendency of the patient toward calculus be decided, and possibly a more intelligent preventive treatment instituted. But a stone is often preserved whole for its beauty, and thus the character of its nucleus remains unknown. Moreover, the practical surgical question of most importance when a stone is in the bladder is its hardness, as bearing upon the question of lithotomy or lithotrity. The substance composing the bulk of the stone decides this question, and therefore, properly, gives its name to the stone.

Among the various classifications which have been proposed, that of Ultzmann,[1] following Heller, is perhaps the most widely adopted and possessed of the greatest merit. It aims at scientific exactness, and deals with the pathological conditions which precede the formation of stone. In this classification the nucleus names the stone, and although sometimes the surgical name of the stone differs from its scientific name as decided by this method, yet, purely for purposes of study, a classification by the nucleus can hardly be improved upon.

But Ultzmann[2] in his latest utterances gives up his former classification on the ground that primary stones may form in the bladder, as well as in the kidney, and secondary stones in both regions. He offers no fitting substitute and I therefore prefer to modify his former classification so as to cover all cases, and to retain it thus modified. Ultzmann's classification was the following:—

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[1] Ueber Harnsteinbildung, S. 156. 1875.

[2] Die Harnconcretionen, S. 15. 1882.

1. *Primary stone formation.*
2. *Secondary stone formation.*
3. *Metamorphosed stones.*

1. *Primary stone formation* of Ultzmann includes stones forming in acid urine, which is normal as far as any inflammatory exudation derived from the tissues is concerned.

2. *Secondary stone formation* includes stones forming in neutral urine—such as the crystalline phosphate and the carbonate of lime, and in urine rendered pathologically alkaline by the products of inflammation of the mucous membrane lining the urinary tract—the phosphatic stones.

3. *Metamorphosed stones*, according to Ultzmann, are certain large kidney and bladder stones with uric-acid nucleus and phosphatic shell. It is claimed that an acid stone lying for years in purulent urine loses its acid crystals, in part or wholly, their place being supplied by alkaline phosphatic precipitates. This metamorphosis of stone is a pure assumption, and Ultzmann does not prove it, or seriously attempt to do so, in either his monograph on stone formation, his work on urinary analysis written with Hoffman, or his pamphlet on urinary concretions. In the last work he does not mention the subject.

It is not uncommon to find a phosphatic stone with a nucleus of uric acid, and it is much more reasonable to suppose that the nucleus, acting like any other foreign body, has produced catarrh of the mucous membrane, and has then become covered with phosphatic incrustation, than it is to believe that the stone has ever been composed entirely of uric acid, and has become partly metamorphosed into a phosphatic stone. This assumption holds as well for the pelvis of the kidney as for the bladder.

Another fault of Ultzmann's classification is, that it places the phosphate-of-lime and carbonate-of-lime stone in the secondary class, and assigns no reasonable position to indigo, urostealith, or fibrin.

I think that the division into primary and secondary stones is an excellent one, with this understanding, that primary stones are such as form primarily from altered urine and colloids, while secondary or symptomatic stones follow as a consequence of inflammatory lesions of the mucous membrane of the urinary tract, without regard to the condition of the urine in respect to its various salts.

Only two stones give any trouble in the classification which I propose: urostealith and amorphous phosphate of lime. I rank them both with secondary stones, because amorphous phosphate of lime, when found at all as a separate stone not combined with the ammonio-magnesian phosphate, is a friable, mortar-like mass entangled in a magma of mucus, and although phosphate of lime is found where there is no catarrh of the urinary passages, yet it is doubtful whether a stone ever forms from it except in the presence of such catarrh.

Urostealith again has never been encountered except in association with mixed phosphates. It therefore seems probable that it only forms in the presence of catarrhal inflammation.

The classification then which I propose is as follows:—

I. *Primary stone*—the mucous membranes of the urinary tract being sound when the stone forms—uric acid (urate of sodium, potassium, lime), oxalate of lime, cystine, xanthine, carbonate of lime, crystalline phosphate of lime, indigo.

II. *Secondary or symptomatic stone*—the mucous membrane of the urinary passage being in a catarrhal state at the point where the stone forms—urate of ammonium, triple phosphate, amorphous phosphate of lime, fusible calculus, urostealith.

STRUCTURE OF STONES AND NATURE OF NUCLEI.

All true calculi are composed of a nucleus, single or multiple, and layers more or less concentric of the same or another material arranged around it. This is the case for large as well as for microscopic calculi, those requiring a magnifying power of 250 diameters (Beale)[1]—Hoffman says 200[2]—to make out their lamination. This fact of lamination alone differentiates calculus from gravel, the latter being crystalline dust or concretions of crystals more or less large, but not possessed of definite structural arrangement.

The nucleus of a stone may consist of whatever, among the organized, crystalline, or earthy constituents of normal or pathological urine, is capable of concreting into a more or less solid mass; or it may be a foreign substance coming from within the body, or introduced from without.

Among the familiar examples of nuclei are separate rhomb-crystals of uric acid and clusters of them; spheres of uric acid; dumb-bells of oxalate of lime, urates, etc.; a lump of inspissated pus, mucus, or blood, perhaps drying out and leaving a central cavity in its place; lumps of tissue-débris (casts, epithelium, fibrin); eggs of entozoa; portions of bone, teeth, or hair, which have escaped from a neighboring dermoid cyst by ulceration into the bladder; bullets, shreds of clothing, and other foreign matter shot into the bladder; portions of bone from fractures of the pelvis; foreign material from the rectum entering the bladder through fistulous communications; portions of catheters, etc.; and, finally, foreign bodies in endless variety which have been introduced through the urethra, usually under the impulse of depraved erotic fancies.

Ultzmann's celebrated collection of 545 single vesical calculi gathered from various quarters, for the purpose of examining the nuclei, yielded 441, nearly 81 per cent., in which the nuclei were composed of uric acid, while from a further study of multiple calculi and those passed spontaneously he concluded that among primary stones the nucleus was composed of uric acid in 94 per cent.[3] Hoffman and Ultzmann declare, in their work on the analysis of urine,[4] that 90 per cent. of urinary calculi have uric-acid nuclei. Ord[5] states that two-thirds of all calculi (this estimate includes secondary stones) "are in bulk composed of, or start from, concretions of uric acid."

From the specimens in the museum in Guy's Hospital, Golding-Bird finds the percentage of nuclei of uric acid and urates to be less than 50. In considering the question of nuclei entirely apart from the nuclei of large stones, it must be remembered that a great number of acid nuclei are voided by the urethra; the patients passing them do not enter hospital, and their minute calculi do not find their way into museums.

Roberts estimates that uric acid forms five-sixths of all primary calculi. Klein found that alternating calculi were most common in Russia, the nucleus being for the most part uric acid or urates, quite often covered with a layer of oxalate of lime. Beale states that two-thirds of all calculi in the different British museums are composed of uric acid,[6] that dumb-bell crystals of oxalate of lime are frequently found as the nucleus of uric-acid calculus, and sometimes a hollow space representing a former clot of mucus or of blood. This latter phenomenon has been recorded by many observers. The well-known case of the Archbishop of Paris, referred to by Coulson and others, in which Frère Côme predicted before operating that the stone inclosed a clot of blood, illustrates probably one stage of calculus with a hollow nucleus. The archbishop had formerly been a victim to hæmaturia, and Frère Côme's guess was verified by the result.

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[1] Kidney Diseases, Urinary Deposits, etc., 3d ed., p. 405. 1869.

[2] Hoffman und Ultzmann, Anleitung zur Untersuchung Harnes, Zweite Aufl. S. 109. 1878.

[3] Op. cit., p. 149.

[4] American translation, p. 264. 1879.

[5] Op. cit., p. 60.

[6] Kidney Diseases, Urinary Deposits, and Calculous Disorders, 3d ed., p. 409. London, 1869.

A remarkable instance of calculus containing a cavity was presented to the London Pathological Society by Mr. Shaw. The stone, composed of uric acid, was as large as a small walnut, but seemed very light. On section it was found to be a shell varying in thickness from a sixth to half an inch, inclosing a large cavity, which latter contained a stone as large as a pea. Doubtless the small stone had become surrounded with a clot of muco-pus upon which uric-acid crystals had precipitated, and after the shell had formed the soft centre had shrunk away.[1] Mr. George Lawson[2] reports a calculus removed by lithotomy from a man of forty-eight. It was $2\frac{1}{2} \times 2 \times 1\frac{1}{2}$ inches in its various diameters. It weighed four ounces less sixty grains. Its surface was smooth, yellowish-white, and inodorous after being washed. Its composition was phosphatic. On making a section, a drachm of reddish-brown, stinking, ammoniacal fluid escaped. The true nucleus turned out to be a mulberry calculus, ragged in outline, seven-eighths of an inch in its two chief diameters. This nucleus lay in a free space which had been filled with the reddish-brown fluid. Mr. Lawson's explanation is the obvious one; that the rough mulberry calculus when free in the bladder had at last excited catarrh, that its interstices had become filled and surrounded by muco-pus mixed with ammoniacal urine, that this smooth surface had then become encrusted by concentric phosphatic laminæ, and that the inclosed contents had still further retrograded into the brownish putrid liquid. Carter found oxalate of lime to be a more common ingredient in stone formation in India than in England.[3] This he ascribes to the vegetable character of the food. The nuclei he found to be composed of uric acid and urates in 50.30 per cent. at Grant College, Bombay, while in England from his sources of information he makes the percentage of stones having uric acid or urates as nuclei as high as 74.46.[4] Oxalate of lime, on the other hand, formed the nucleus in 38.65 per cent. at Grant College, while the English sources yield only 16.87 per cent.

Carter, from his Indian researches, concludes[5] that globular urates very often accumulate to form the nucleus of stone; that oxalate of lime in sub-morphous form is very common; but that crystals of uric acid "comparatively seldom compose the nucleus of a calculus." Dumb-bell crystals of oxalate of lime are conspicuous for their frequency among the spicular, granular, and globular urates when the latter occur as the nucleus of stone.

As to structure, Carter's microscopic researches confirm the conclusions of Ord. The albuminous substance is the skeleton in which the solid material forms. Dissolving out the latter leaves the former quite perfect, in some cases, showing the fibrillated radial structure of the basis-substance. In this substance crystals and granules are deposited, the former assuming a peculiar crystalline arrangement (sub-morphous), while the latter undergo remodelling. This arrangement of the basis-substance in a fibrillated, radial manner is very similar, as Ord has pointed out, to the structure existing in the crab's shell as described by Mr. Rainey, and serves, according to Ord, to prove the soundness of the doctrine of molecular coalescence as applied to the formation of calculi.

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[1] Trans. Path. Soc. Lond., vol. vi. p. 251.

[2] Lancet, March 31, 1883, p. 545.

[3] Calculous Diseases in Bombay and some other parts of India. St. George's Hosp. Reports, 1871–2, p. 85.

[4] The original paper makes these figures 71.79.

[5] Microscopic Structure, etc., of Urinary Calculi, p. 29. 1873.

RATE OF GROWTH OF URINARY CALCULI.

Compact acid stones—uric-acid, and oxalate-of-lime—generally form slowly. Gross cut a man who had had symptoms of stone for twenty-six years, and the calculus was only as large as a hen's egg. I removed two ounces of acid stone from a boy of nine. No fixed rate can be named, the increase being doubtless mainly dependent, in acid stones, upon the proportion in the urine of the ingredient which is being deposited. The estimates of Meckel that primary stones gain from two to six lines in diameter yearly, and of Gross that the increase is from one to four drachms yearly, are little better than guesses.

Ultzmann attempted scientifically to establish the rate of growth for primary stones by keeping them in acid urine which he renewed daily. He found that a number of small stones so treated in his own urine weighed on an average ten times as much at the end of the year as they did at the beginning. He concludes that the rapid rate of increase can only hold good in the case of small stones.[1]

Phosphatic stones grow more rapidly, as a rule, than acid stones, but they increase at a varying rate, the grade of the catarrhal process probably having more to do with it than anything else. I removed a hair pin from a young girl's bladder where it had remained unmolested for more than a year, yet it was encrusted with less than a drachm of phosphatic deposit.

Poulet[2] refers to a calculus, removed by lithotomy, which weighed two and a half ounces, and which had for its nucleus a soft catheter introduced by the patient ten months previously. This patient undoubtedly had had catarrhal cystitis, with atony and retention, for which he had introduced the catheter in the first place. Hence the rapidity of stone formation. Robert Abbe[3] removed by lithotrity, from a man of 70, an entire soft catheter and phosphatic material with which it had been encrusted. The phosphates only weighed forty grains, although the catheter had been in this old man's bladder for seven months. These instances are sufficient to show the irregularity of the rate of growth of stones of either class.

GROSS CHARACTERS OF URINARY CALCULI.

Calculi present peculiarities in shape, surface, color, size, weight, consistence, and number.

Shape.—Calculi are ordinarily oval or rounded in form, and more or less flattened.

Ultzmann argues[4] that the shape of any single stone forming in the bladder, the growth of which is not interfered with by accidental causes, is regulated by the system of crystallization to which belong the original crystals out of which the stone is composed. Thus uric-acid, phosphatic, and cystine stones are naturally of the flattened-oval type, having three main diameters, because their crystals tend to assume rhomboidal forms possessing three diameters. The oxalate-of-lime crystal belongs to the quadratic system, with two axes nearly equal; hence these stones are globular. Calculi show facets, if a number of them have been lying together, and if formed upon a foreign body they often approximate the shape of that body. They are found with hour-glass constrictions—notably where one part of the stone is encysted and another part free in the bladder, and very fantastic, branched shapes are often assumed by renal stones and by vesical phosphatic stones, which branch off sometimes into the ureter and sometimes into the urethra.

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[1] Op. cit., p. 162.

[2] Treatise on Foreign Bodies, etc., American translation, vol. ii. p. 155. 1880.

[3] Medical Record, December 24, 1881, p. 705.

[4] Die Harnconcretionen, p. 9. 1882.

Surface.—The surface of a calculus may be as smooth as glass, but it is generally rough. This is especially the case in oxalate-of-lime calculi. Phosphatic stones are sometimes quite smooth, sometimes worm-eaten on their surface.

Color.—Calculi vary through nearly all shades, from white through yellow to brown with tints of green, up to dark brown, nearly black. The color depends mainly upon urinary pigments, not upon admixture with blood.

Size.—Calculi vary from microscopic size upwards. The largest I have seen is the kidney stone removed after death by MacGregor.[1] It measured 16⅝ by 12½ inches in its two circumferences. Several others, vesical stones, of about the same circumference have been recorded. A stone one inch in diameter is considered surgically a medium-sized stone (Thompson), all below being small, and all above large.

Weight.—This also varies from a fraction of a grain upwards. Gross refers to stones extracted by lithotomy, weighing as little as four, five, six, eight, or ten grains. Gross and Coulson have each removed a five-grain stone, and Ashhurst one of less than two grains, from a boy, by lithotomy. On the other hand, stones have been found weighing 50 ounces (MacGregor's weighed in the fresh state 51 ounces), while there is one stone on record, said by Coulson to have been in the possession of the French lithotomist Morand, which weighed 6 pounds and 3 ounces. The largest stone ever removed from the bladder successfully, of which I find any record, was a stone of over 20 ounces, removed after fragmentation by Dunlap, of Springfield, Ohio,[2] from a man of 66. The patient lived nearly three years after the operation. Pulido's scrotal stone of 23½ ounces occurred in a successful case, and Graefe's 26-ounce scrotal stone in another.

The largest stone which was ever extracted from a living person, as far as I can ascertain, was a phosphatic concretion measuring 17 inches around its largest circumference, and weighing 40½ ounces. This enormous mass was removed from a man of 39 by the supra-pubic operation. Uytterhoeven, of Brussels, was the operator. The patient died eight days afterwards. Leroy d'Étiolles records the case.[3]

Among other cases of very large stone removed by the supra-pubic operation—with a fatal result in each and every instance—are the often-quoted historical examples of Vitellius, 22 ounces, and Deguise, 31 ounces, as well as the more recent ones—also fatal—of Monod, 346 grammes (nearly a pound), and of Després, the elder, two pounds.[4]

A rather large stone of pure cystine, and notable on that account, with diameters 2½ × 1¾ × 1 and a circumference of 7 inches, weighing a little more than 2½ ounces, is recently reported[5] to have been successfully removed by John Treameane, in Australia, by the high operation.

Consistence.—Oxalate of lime forms the hardest variety of stone. It is difficult to break, and fractures in angular fragments from the centre. The phosphatic calculi form in flakes and in a mortar-like mass. They are nearly always rather soft, but are sometimes quite hard. Cystine calculi have a waxy consistence.

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[1] Am. Journal of Med. Sci., Jan. 1877, p. 120.

[2] Gross's System of Surgery, 6th ed., vol. ii. p. 752.

[3] Traité pratique de la gravelle, etc., 2e éd., p. 95. Paris, 1869.

[4] Bull. de la Soc. de Chir., 5 Déc. 1881, p. 758.

[5] Australian Med. Journ., and Journal of Am. Med. Assoc., Dec. 8, 1883, p. 649.

Number.—Often single, calculi may be as numerous as in the case of Murat, alluded to by Coulson, who vouches for 678 stones in the bladder and 10,000 in the kidneys of an old man. Physick extracted over 1000 stones[1] from the bladder of Chief Justice Marshall, of the Supreme Court of the United States. None of these stones was larger than a bean.

Dr. Ellis Blake, of New York, once showed me the bladder of a woman, distended to about the size of a small fist, absolutely full of stones about the size of duck shot. They were not counted. This patient, during life, had passed these minute stones freely. Sometimes they would drop from her as she moved about. Oxalate-of-lime calculus is rarely multiple.

Spontaneous Fracture of Calculi.

The spontaneous fracture of calculi within the bladder has been explained by Ord.[2] Other observers had already written concerning it,[3] but their theories of its cause are less satisfactory than that given by this writer.

Ord examined a number of specimens from various sources, and reported upon them to the London Pathological Society. He believes that the splitting is due to the imbibition, by the mucous cement of a calculus, of urine of different reaction and specific gravity from that in which the stone was originally formed. He quotes the paper of Southam[4] giving two cases observed by that surgeon, one by Luke, and one by Liston, and a drawing of a calculus from the Musée Dupuytren, in Paris. Southam thought that the rupture was effected by the development of gas within the stone, but Ord believes that the internal force is the swelling of the colloid nucleus by the imbibition of fluid different from that in which the stone was formed. This swelling of the nucleus, Ord[5] says, acts as a "bursting charge in a shell." Coulson has recorded a case, where, according to his belief, two soft calculi crushed each other by mutual friction. Liston's calculus is supposed to have broken up under the influence of violent bodily shock. Ord has collected a number of cases in which the swelling of the nucleus alone could account for the disintegration. He also, in another place,[6] records an example of molecular disintegration of a calculus, as shown in a stone taken after death from the kidney.

Ord concludes[7] that the spontaneous fracture of calculi may be due to the action of three causes: (1) Forces arising within the calculus itself. (2) Molecular disintegration. (3) Weakness of some of the alternating layers within the outer shell of the calculus.

When a calculus undergoes spontaneous rupture within the bladder, each fragment, unless expelled, becomes the nucleus of a new stone. In this way, Ord believes, some examples of multiple calculi take their origin. His[8] most recent expression on this subject is a report upon Smith's case, in which he found spores and mycelium, and in which he thinks that the fungus may have had something to do with the disintegration.

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[1] Gibson, Institutes of Surgery, 5th ed., vol. ii. p. 220.

[2] Trans. Path. Soc. Lond., vols. xxviii. p. 170, xxix. p. 161, xxx. pp. 314–320; and op. cit., p. 93.

[3] Otto Schmidt, Beiträge zur chirurgischen Pathologie der Harnwerkzenge. Leipzig, 1865; quoted by Gross (Practical Treatise on the Diseases, Injuries, and Malformations of the Urinary Bladder, etc., p. 215).

[4] Brit. Med. Journal, vol. i. p. 3. 1868.

[5] Ibid., Sept. 7, 1878, p. 347.

[6] Trans. Path. Soc. Lond., vol. xxxi. p. 185.

[7] Spontaneous Disintegration of Calculi. Brit. Med. Journal, May 10, 1879, p. 702.

[8] Trans. Path. Soc. Lond., vol. xxxii. p. 304.

MATERIALS WHICH ENTER INTO THE COMPOSITION OF URINARY CALCULI.

The colloidal, albuminous, fatty, epithelial, purulent, extractive, and coloring matters found in varying proportions in calculi, as well as foreign substances introduced from without or coming from within the organism and forming nuclei, may be disregarded in considering the present question. Such substances as the urates of lime, magnesium, potassium, and sodium, and the carbonate of magnesium, which may occur in minute proportions mixed with other ingredients of a calculus, only call for casual mention, as well as the earthy matters found as a trace—silica (Berzelius, Vauquelin, Fourcroy, Venables, and others), iron, myeline, hæmatoidin (Ultzmann), and cholesterine. When a calculus is found to be formed largely of cholesterine, it is fair to suppose that a gall-stone has found its way into the urinary passages. An interesting article by Ludwig Güterbock[1] details a case of extraction by lithotrity from the bladder of a middle-aged woman, of a number of calculi weighing thirteen grammes, composed of cholesterine, with a little uric acid deposited in an outside layer about each calculus. This patient denied having had any previous malady, and the stones were too large to have been introduced from without through the urethra. No biliary constituents were found in solution in the urine, and, as the patient recovered, it was not learned how the gall-stones had reached the bladder. Güterbock refers to two cases previously reported, those of Faber and Pelletan (both in women). In the former, an autopsy demonstrated a communication between the gall-bladder and urinary bladder. Pelletan's patient had suffered pain in the right side for some time before the two hundred facetted gall-stones escaped by the urethra—which they did in a period of eight days—but in Güterbock's case nothing pointed to previous biliary complications.[2]

The substances which form urinary calculus, constituting the bulk of the mass or well marked laminæ, are the following:—

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[1] Gallensteinconcremente in der Harnblase, Archiv für path. Anat. u. Phys., Bd. lxvi., Hft. 3, S. 273.

[2] Prostatic concretions are not urinary calculi. Their consideration belongs to another article. Fecal calculus, so called, has been described, among others, by R. Williams (Lancet, Oct. 1, 1881). A small vesico-rectal fistula existed in an old man with large prostate. Cancer of the bladder with perforation was diagnosticated. After death, ten drachms of hard, solid, fecal material was removed from the bladder, not coated with phosphates. No cancer was found. James Miller (Edinburgh Medical Journal, 1829, vol. xxxi. p. 61), in a letter to Liston, describes a curious fecal and urinary calculus as large as a turkey's egg, which he extracted from the rectum of a child who had been operated upon for imperforate anus, and in whom a communication existed between the rectum and bladder. The stone had to be bored into and crushed, and the anus and rectum freely incised, before the calculus could be removed. The stone consisted of a nucleus of primitive greenstone which the boy had swallowed, a coating of the fibrils of the pencil of oats, such as Wollaston found in the spongy portion of human alvine concretions in Scotland, and an outer coating, from half to three-fourths of an inch thick, of urinary mixed phosphates. Miller refers to a rectal concretion described by Marcet (Essay on Calculous Disorders, p. 126), as found in the rectum of an infant born with imperforate anus and having also a recto-vesical fistula. This stone was composed of mixed phosphates.

Among the irregular substances found as calculi, stones introduced from without must not be lost sight of. Under the title "De la gravelle urinaire simulée et de ses rapports chez la femme avec l'hystérie," Brongniart has collated twenty histories of cases full of curious interest in the Ann. des Org. Génito-Urinaires, Nov. 1883, p. 747.

Urinary calculi in animals are occasionally reported. Ebstein's recent scientific treatise on the Nature and Treatment of Urinary Calculus (Wiesbaden, 1884), discusses this subject quite fully. The Trans. Path. Soc. Lond., vol. xxxiv. p. 326, refers to a stone taken from the bladder of an ass and one from the bladder of a dog, both of carbonate of lime. I have a small box full of minute calculi of carbonate of lime, passed by a bull. Dr. D. G. Sutherland, of East Saginaw, Mich., presented me with a portion of a five-ounce urinary calculus of carbonate of lime cut from a mare on January 24, 1884. The animal survived. Mehu gives the analysis of four calculi of carbonate of lime from the bladder of a rabbit in Ann. des Organes Génito-Urinaires, t. i. No. 7, 1883, p. 454.

OF VERY COMMON OCCURRENCE.

1. Uric acid.
2. Oxalate of lime.
3. Mixed phosphates (lime, ammonium, magnesium).

OF LESS COMMON OCCURRENCE.

4. Urate of ammonium.
5. Ammonio-magnesian phosphate.
6. Phosphate of lime.
7. Carbonate of lime.
8. Cystine.

EXCESSIVELY RARE.

9. Xanthine.
10. Fibrin.
11. Urostealith.
12. Indigo.

Any of these substance may occur as the chief constituent, but one or more may also be deposited in the same calculus forming superimposed layers, the *alternating calculus.* Generally, for obvious reasons, the phosphates form the outermost layer. The layers indicate the condition of the urine at the time each was being formed. According to Coulson,[1] *alternating calculi* constitute almost fifty per cent. of all specimens found in museums. Cystine, xanthine, urostealith, indigo, and fibrin, always stand alone, and do not form alternating layers in calculi—but any one of them may act as a nucleus and become coated with phosphates. Urostealith is only found in company with the phosphates, while indigo has been observed by Ultzmann in crystalline form, included in or surrounding deposits of uric acid and oxalate of lime. Fibrin, as blood clot, is not very uncommon as a nucleus of a calculus —even a primary calculus.

Description of the Various Types of Urinary Calculus.

Uric-acid calculus is the most common form encountered in the human subject. It was described in 1776 by Scheele.

The calculus of old men with enlarged prostates is an exception to the rule, being most often phosphatic. The uric-acid stone may be composed almost exclusively of uric acid, or may be mingled in its intimate structure, or in alternating layers, with more or less oxalate of lime and different urates. It is generally oval, rarely very large, and sometimes quite smooth, though more often granular or smoothly tuberculated. In color it varies from a light fawn (Owen Rees has seen a uric-acid calculus perfectly white) to a brownish or even a blackish-red. The so-called pisiform uric-acid calculus is a pea-like body, often possessed of many facets, occasionally single, generally multiple, and often of a pale yellowish-white color from a coating of urate of ammonium. Of this kind are commonly the stones passed at intervals by gouty patients during a series of years.

Section discloses two forms of structure in uric-acid calculi, the laminated and the amorphous. A given stone may contain layers of both forms.

The *laminated uric-acid calculus*, when cut through the centre and polished, resembles an agate. It displays a concentric arrangement of regularly curved lines of slightly varying color and thickness, looks crystalline when broken, and takes a high polish. Radiating lines are often observed upon it, extending from the centre to the periphery. The stone is generally very hard. It breaks with a loud noise, upon the application of sufficient force, into angular fragments along its laminæ and radiating lines.

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[1] Op. cit., p. 341.

The *amorphous uric-acid calculus* is generally of a dirty reddish-yellow color, looking gritty, structureless on section or fracture, perhaps presenting radiating lines from the centre. Sometimes it is found with a radiating crack, indicating a tendency to spontaneous fracture, which is said to be more common in this than in the laminated variety. This form is sometimes quite soft, and breaks into irregular, angular fragments.

OXALATE-OF-LIME CALCULUS, OR MULBERRY CALCULUS, was described by Wollaston in 1797, and occurs next in frequency to uric-acid stone among primary calculi. It is generally round, occurs singly in the bladder, and rarely exceeds the size of a nut. It is usually covered with blunt asperities—whence the name—and varies in color from dark gray through brown to black. Sometimes the asperities are crystalline, small, sharply angular, and shining. The oxalate-of-lime stone is commonly mixed with more or less uric acid, the different urates, and some carbonate of lime, with, often, a certain amount of blood. The blood comes from the mucous membrane of the bladder, irritated by the asperities upon the stone, and, lodging in the depressions between these asperities, it becomes incorporated with the stone. The same roughness often sets up more or less catarrhal inflammation of the bladder, and leads to a peripheral deposit of phosphates.

Hemp-seed calculus is a sub-variety of the oxalate-of-lime stone. It occurs in the kidney, and is a rounded, smooth, brown-colored body, somewhat resembling a hemp-seed. It is generally of mixed composition, containing oxalate and phosphate of lime in different proportions.

Other varieties of oxalate-of-lime calculus have been noted. Dr. Yelloly describes one of a white or pale-brown color, and crystalline in structure throughout. Mr. Poland[1] refers to this, and speaks of an oxalate-of-lime calculus which he extracted, pale-brown in color, which immediately crumbled, there being little or no animal matter in its composition; and still another variety has been described by Mr. Charles Williams, a milk-white calculus of highly polished surface, generally encountered in the kidney, and having no crystals on its surface, but sometimes spinous projections.

Oxalate-of-lime stone is excessively hard, and resists the lithotrite more than any other calculus. It breaks with a sharp report into jagged, angular fragments. On section it shows concentric laminæ, deposited in undulating lines about the nucleus. The layers vary through shades of light yellow and brown, to greenish or blackish-brown.

MIXED PHOSPHATIC OR FUSIBLE CALCULUS.—This is the variety of stone produced by catarrhal changes in the mucous membrane with which the urine lies in contact. It is this phosphatic material which encrusts ulcers, tumors, and foreign bodies in the bladder. It forms the phosphatic layers about other varieties of stone, and is the concretion commonly encountered in cases of enlarged prostate. In the total list, all stones considered, the fusible calculus stands second, being estimated to form one-twelfth of the total number, against one-seventeenth for oxalate-of-lime stones and five-sixths for those of uric acid.

The fusible calculus was described by Wollaston in 1797. It is dull, dirty-white in color, varying in bulk from pin-head size up to that of enormous masses, filling the bladder and weighing several pounds. These stones are for the most part multiple, showing facets from mutual contact. When single, their shape is not generally symmetrically round or oval, but irregular in some way. These are the stones that grow in a branching manner from the bladder into the prostatic sinus, into the ureters, and into sinuses and sacculi. Quite often, in fusible calculus, the nucleus is not central.

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[1] Holmes's System of Surgery, vol. iv. p. 1024.

This variety of calculus is often light, soft, and mortar-like, crumbling readily under the lithotrite. It breaks into irregular pieces or in laminæ, and is more or less hard, according as the triple-phosphate or the phosphate of lime prevails in its composition. So also its structure varies. Some specimens are white and structureless, others amorphous and crystalline, and others again laminated, and exhibiting triple-phosphate crystals between the slightly adherent laminæ.

URATE-OF-AMMONIUM CALCULUS, discovered by Fourcroy and Vauquelin in 1798, and described particularly by Prout in 1823, is yet a subject of some discussion. Roberts thinks that it may be doubted "whether the calculi described by Prout as urate-of-ammonium, were really anything more than fawn-colored uric-acid." Yet observers agree that the urate of ammonium does occasionally occur as a calculus, mainly in the kidneys and bladders of children. It does not reach a large size, and is flattened, oval, smooth, or granular, and slate-gray or clay-colored. Its structure is close and finely laminated, but the laminæ are so intimately united that the fracture often looks amorphous. The laminæ, however, are easily separable. The stone is brittle and is suitable for lithotrity.

AMMONIO-MAGNESIAN PHOSPHATE.—This substance, also discovered by Wollaston, in 1797, and commonly called triple phosphate, occurs occasionally as the main constituent of a calculus. It is rare to find it alone, but common as a layer in an *alternating calculus*, or combined with phosphate of lime in the *fusible* calculus. Sometimes alone it forms a secondary calculus upon a foreign body as a nucleus (Bryant).

Calculi of triple-phosphate are white, unevenly round, rough, and crystalline on the surface, chalky and crystalline in texture, and not laminated. They become dulled in appearance when dry and old. Their bulk varies from a minute size up to that of very large concretions, weighing many ounces. Thompson speaks of one weighing nearly two pounds. They are very friable, and excellent objects for the lithotrite. The mass is made up of stellate, bibasic phosphate, and of neutral, ammonio-magnesian, phosphatic prisms (Wollaston).

PHOSPHATE OF LIME, quite common in combination (*alternating and fusible calculus*) is very rare as the main ingredient of a stone. Wollaston described this substance in 1797. Two forms are mentioned: (1) renal, (2) vesical.

The *renal* phosphate-of-lime calculus is pale-brown, smooth, oval, and small, composed of neutral phosphate of lime, and made up of loosely united laminæ, sometimes showing radial markings. The material is soft and friable, and the laminæ easily disconnected. These stones contain a large proportion of animal matter. The neutral phosphate fuses with the blowpipe.

The *vesical* bone-earth phosphatic calculus is very rare. It is a mortar-like substance, semi-crystalline, entangled in a magma of mucus. The basic phosphate of lime is not fusible with the blowpipe.

CARBONATE-OF-LIME CALCULUS.—This form, although common in herbaceous animals, is rare in man. Carbonate of lime not infrequently occurs as an ingredient in the oxalate-of-lime and in the phosphatic calculus. As the main element of stone it is exceedingly rare, except in the case of prostatic concretions.

The carbonate-of-lime calculus was first described by Brugnatelli, in 1819. It forms in the kidney as a rule, and is generally multiple. Among the most noted cases are those of Haldane, Hunstone, and Waggstaffe, all carefully described by Roberts, who personally made a careful study of the specimens passed from the patient under the care of Mr. Hunstone. In Hunstone's case, says Roberts, "myriads of minute calculi of carbonate of lime were voided with the urine," "the largest of which were about the size of poppy-seeds, and the smallest only just visible to the naked eye as bright specks." Waggstaffe's carbonate-of-lime calculus was a "large branching calculus" taken from the kidney after death.

Usually these calculi are small, rarely larger than a nut. They may be white and friable (Prout), but are generally gray, yellowish, brownish, or even reddish, or bronzed, or amber-colored, and quite translucent (Roberts). They are exceedingly hard, and on section show a varying arrangement of curved lines about one or more nuclei, resembling in structure the mulberry calculus.

CYSTINE OR CYSTIC-OXIDE CALCULUS.—This form is almost sufficiently uncommon to claim a place in the third group of stones, those I have designated as "excessively rare." Arnaldo Cantani, in his essay on Cystinuria, etc.,[1] states that cases of cystine stone have only been reported 59 times in medical literature up to the date of his paper.

Wollaston discovered cystine in 1810, and believed it to be an especial and exclusive product of the walls of the bladder, but soon after Marcet found it in a kidney-stone, and Scherer in the liver. In 1824, Stromeyer and Prout found it in the urine where there was no calculus. Owen Rees thinks it more common in dogs than in men. Cleotta found it in the kidney of the ox. Beneke, in 1850, found only 3 cystine calculi among the 649 of Hunter's Museum. Leroy d'Étiolles, among 1100 stones, found only 6 of cystine. Ivanchich encountered 1 in 300 cases of lithotrity, and Dumreicher 4 in 105 operations. Golding-Bird found 11 among the 374 calculi in Guy's Hospital Museum. Ultzmann has 8 in his table of 545 stones, 3 of which are in his special collection of 200 stones.[2] Civiale, up to 1851, seems to have encountered cystine only 8 times. Carter says that it forms less than 1 per cent. of the stones in the Museum of Grant College, Bombay. It is exceptionally uncommon in the United States. Buck's collection in the New York Hosital contains one of large size removed by lithotrity.

Cystine may form a calculus in the kidney or in the bladder, either constituting the exclusive constituent of the calculus, or forming the nucleus. It is encountered in connection with the mixed phosphates, uric acid, and oxalate and carbonate of lime. All observers report heredity as an active cause in its production. Cystine stones occur singly, but are often multiple. They are generally small, but have been found in the bladder weighing several ounces. They are rounded, smooth, or occasionally worm-eaten on the surface. Generally yellowish, they may be white or quite dark. On section they are smooth, pale-green, waxy-looking, not laminated. The fracture looks semi-transparent, satiny, and glistening. Golding-Bird says that the yellowish color changes to a blue-green when the stone is long kept exposed to the light.

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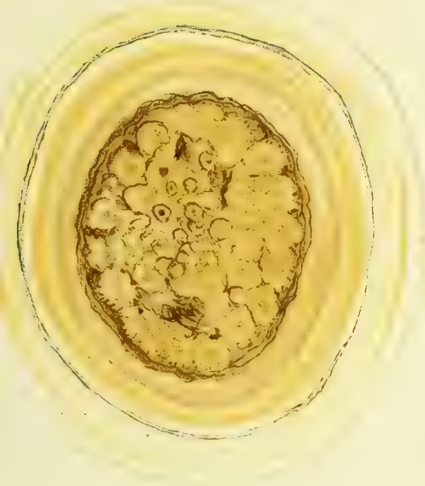
[1] Cystinuria, Fettsucht und Gallensteine. Berlin, 1881. The German translation, by Seigfried Hahn, forms part of the third volume of the Specielle Pathologie und Therapie der Stoffwechselkrankheiten.

[2] Die Harnconcretionen, S. 41. 1882.



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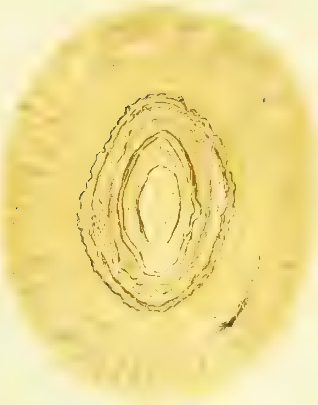

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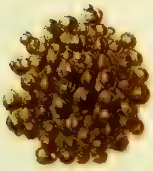

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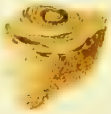

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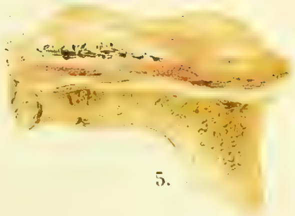

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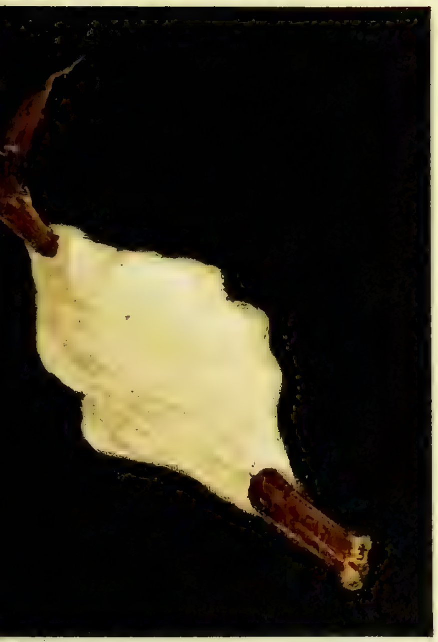

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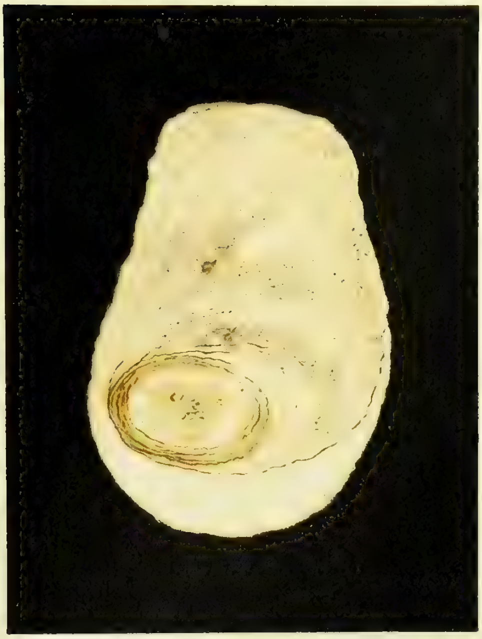

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H. BENCKE, LITH. N.Y.

URINARY CALCULUS.

Cystine calculus is rather soft and friable, and is entirely suitable for lithotrity.

XANTHINE, XANTHIC-OXIDE, OR URIC-OXIDE CALCULUS.—Coulson[1] gives a bibliography and description of the seven cases of xanthine stone which were known to have existed at the date of his last edition, the first discovered by Marcet in 1815, weighing eight grains (Coulson by a misprint says ounces), and the last reported in 1873, by Gaillard, removed from a boy of 13, and weighing 350 grains.

Dr. Porter, of Bridgeport, adds an eighth case, the only one recorded in America, the stone having been passed spontaneously from the kidney by a young lady. It weighed 48 grains. I have reproduced its appearance in section, in the plate which accompanies this article. (Plate XXXIII., Fig. 4.) Dr. Porter's remarks upon the case are full of interest. They appeared in the "New England Medical Monthly," for May, 1882.

Ultzmann, among thousands of stones examined, never encountered xanthine, and seems rather to doubt its existence. These stones are generally small, and resemble those of uric acid. They vary from a light to a reddish-brown, are smooth and polished externally, laminated on section, but without radiate structure, assume a waxy look when rubbed, and about equal uric-acid stones in hardness. They are generally single. They have been passed spontaneously and obtained by the aid of lithotomy—but no specimen, as far as reported, has been crushed with a lithotrite. They are suitable for removal by this method.

FIBRINOUS AND BLOOD CALCULUS.—Marcet was the first to describe this very rare form of calculus. His specimens were quite small, and were passed spontaneously by a gentleman of 50. Roberts encountered a similar calculus voided by a man of 35. Prout has seen and described several. Scott Alison (quoted by Beale) found several in the kidney, one as large as a horse-bean. They have been described as whitish-gray, amber-colored, dark reddish-brown, and black. They are usually small. Roberts has one as large as a walnut, taken from the bladder of a sheep. They are generally rough, and either hard, brittle, friable, with a fracture which has been described as rusty, dull, like baked clay, or of waxy consistence, or showing fibrous texture upon fracture. They are more often multiple than single. Prout believes that they are composed of fibrin, and all agree that their occurrence is liable to be associated with previous renal hæmaturia. In a neutral saline solution of one of these concretions Owen Rees found the remains of blood-corpuscles.

UROSTEALITH; FATTY OR SAPONACEOUS CALCULUS.—This material is known to have formed calculous concretions in only four instances. Two vesical calculi, from the same individual, composed of a central saponaceous substance surrounded by a thick coating of phosphates, are now in the Museum of the Royal College of Surgeons, London. They belong to Hunter's collection, and are described in the catalogue of 1842. The presence of the earthy soap forming the centre of the calculus is ascribed in the catalogue to the fact that soapsuds had been used to wash out the patient's bladder, and it is suggested that the fatty acids, combining with the earthy bases of the urine, had formed a nucleus of "earthy soap," which in its turn had become surrounded with phosphates. Heller[2] described some similar masses in 1845, which, as small pisiform bodies, passed from a young man of 24. W. Moore,[3] of Dublin, in

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[1] Op. cit., p. 328.

[2] Harnconcretionen, S. 146.

[3] Dub. Quart. Journ. of Med. Sci., vol. xvii. p. 473.

1853, observed two small calculi of saponaceous nature, and subsequently two large ones were taken after death from the same patient; and Vidau[1] has added another, in which the stone was as large as a bean, to the cases already known. Ultzmann,[2] finding no urostealith among the thousands of stones which he has examined, concludes that this substance is a foreign matter which has been introduced from without, and therefore that it is not a true calculus. Thus it appears that urostealith has only been encountered in four patients. It consists of a yellowish or brownish material, which dries into a waxy-looking mass. It seems always to be associated with a deposit of earthy phosphates, both interstitially and often as a distinct, external layer.

INDIGO CALCULUS.—Ord[3] has described the specimen of indigo calculus which he showed to the London Pathological Society, March 5, 1878. Dr. Bloxam removed it after death from the right kidney of a patient, the other kidney being sarcomatous and containing an alkaline calculus. The indigo specimen was of a dark-brownish color in part, in part blue-black. It made a blue mark upon paper. It was about an inch in circumference, and weighed 40 grains. This is the only calculus of this sort thus far recorded. Ord expressed his belief to the Pathological Society that, as the ureter of the left kidney was occluded by a sarcomatous mass, some material produced by the disease in that kidney had been absorbed and excreted as indigo by the other.

Ultzmann[4] has never encountered a calculus formed of indigo, but considers this substance not uncommon in connection with other deposits (uric acid and oxalate of lime). He possesses a uric-acid stone covered with a layer of indigo as thick as paper, and gives a beatiful photograph (Plate 7) of a microscopic section of stone, showing a number of blue crystals of indigo shut in within a mass of colorless oxalate of lime.

CHEMICAL ANALYSIS OF STONE.

To examine a stone thoroughly it must be sawed through its nucleus, and the latter, with portions of the various concentric layers, separately tested. The best plan which I have found for conducting this examination methodically, is that laid down by Loebisch,[5] and, with certain modifications, I have followed it. The dust collected from the sawing of the stone may be first roughly examined to obtain general information. In burning some of this in a Bunsen flame, further investigations may be largely directed by noticing whether the powder burns totally away or leaves a residue, whether the flame possesses color, or the smoke odor, and whether the powder crackles in burning (oxalate of lime).

A minute fragment, to be tested, is pulverized and held at a red heat upon a bit of platinum-foil over a spirit lamp or Bunsen burner:—

A. It is entirely consumed, except a trace: the fragment is composed of organic matter; that is, uric acid, urate of ammonium, cystine, xanthine, fibrine, urostealith, or indigo.

B. It is not very sensibly reduced in bulk by heat: the fragment is composed of inorganic matter—lime, potassium, sodium, or magnesium, in the form of urate, carbonate, oxalate, or phosphate.

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[1] Journ. de Pharm. et de Chim.; and Loebisch, Anleitung zur Harn-analyse, zweite Aufl. S. 418. 1881.

[2] Op. cit., S. 5.

[3] Op. cit., p. 144.

[4] Op. cit.

[5] Op. cit., S. 415.

A. Organic Constituents.—I. Dissolve a little of the powder with dilute nitric acid in a thin porcelain dish, dry it over a spirit lamp, and allow it to cool. Touch the yellowish-red sediment with a glass rod carrying a drop of liquor ammoniæ. A beautiful purple-red (murexid) reaction shows *uric acid.* This reaction is the same for uric acid and the urate of ammonium. To distinguish between them, boil some of the powdered stone in water. The urate is dissolved, the uric acid very slightly. The clear hot water decanted, and allowed to cool, deposits the urate. Some of this dust is collected and boiled with liquor potassæ. The fumes of ammonia are given off, recognized by the peculiar odor; yellow turmeric paper turns brown in the vapor; a rod moistened in acetic acid becomes surrounded with white fumes. These positive tests indicate *urate of ammonium ;* their failure shows uric acid alone.

II. The murexid test fails. Dissolve a portion of the powder in dilute nitric acid and dry slowly with the spirit lamp; a lemon-yellow deposit is left, which shows no change with ammonia, but becomes reddish-yellow on adding a drop of liquor potassæ. This reaction shows *xanthine.*

III. The burning powder on the platinum-foil gives off a disagreeable sulphurous odor. The powder dissolves in a solution of ammonia. Acids re-precipitate it. The alkaline solution, allowed to evaporate, deposits the flat hexagonal crystals of *cystine.*

IV. The burning powder smells like burning horn. Water, alcohol, and ether fail to dissolve the powder. Liquor ammoniæ or liquor potassæ dissolves it, and from such a solution acids re-precipitate it. It swells up in acetic acid, and promptly dissolves in boiling nitric acid. These tests indicate *fibrine.*

V. The powder melts on the foil, then swells up and gives off a strong odor, recalling that of a mixture of shellac and benzoin. Ether dissolves it, and evaporating leaves an amorphous deposit, which, being heated, assumes a violet color. Vidau's urostealith calculus gave a negative result to this test. The powder dissolves into a soapy solution in warm, caustic alkalies. It dissolves with slight effervescence in nitric acid, precipitates on evaporation without change of color, and the deposit becomes dark-yellow if touched with an alkali. These tests indicate *urostealith.*

VI. The powder of Ord's *indigo* stone, on heating in a test-tube, developed purple-red fumes, which deposited dark-blue crystals on a cool surface. The crystals were characteristic, long hexagonal plates with pointed ends. The odor was sooty, like that of indigo. Strong sulphuric acid dissolved the powder first into a brownish, and then into a muddy-blue solution, which, after dilution with water and filtration, yielded a clear blue fluid. The spectrum gave the indigo line in the yellow. Besides indigo, the stone contained phosphate of lime and a trace of blood.

B. Inorganic Constituents.—When a considerable residue is left after burning the powdered fragment upon a piece of platinum-foil, the stone is composed either almost entirely of inorganic ingredients, or of organic salts, the earthy inorganic bases of which are not consumed by fire: such as the urates of potassium, sodium, lime, or magnesium; the oxalate, carbonate, or phosphate of lime; the ammonio-magnesian phosphate.

I. The murexid test applied to the powder shows uric acid, but the residue left on heating proves the existence of an earthy base; it is soda, potassa, lime, or magnesia. The urates generally exist in small quantity along with other ingredients; they do not alone form stone. The powder is boiled in distilled water and filtered while hot. The filtrate is evaporated and the residue brought to a red-heat. If a portion of the ash held in a Bunsen flame burns yellow, sodium is present; if violet, potassium.

Magnesia and lime exist (if at all) in the precipitate of the boiling water, after moderate heating, as carbonates. A portion of the powder is dissolved in dilute hydrochloric acid, made neutral with ammonia, and the precipitate dissolved with acetic acid; on adding oxalate of ammonium a white crystalline precipitate is thrown down (oxalate of lime). This test shows *lime*. After filtering out this precipitate the filtrate is treated with phosphate of sodium, and *magnesium* shows itself under the microscope as a precipitate of crystals of triple phosphate.

II. The murexid test fails. The powder consists of oxalate of lime; of carbonate of lime or magnesium; of triple phosphate, of secondary (neutral) phosphate of lime, or of tertiary (basic) phosphate of lime.

Oxalate of Lime.—The powder of this substance crackles under the blowpipe, red heat blackens it, further red heat whitens it, and it becomes carbonate of lime, which now dissolves in dilute acids with effervescence. White heat reduces the powder to caustic lime, which no longer dissolves in dilute acids with effervescence, but turns moistened yellow-turmeric paper brown. Furthermore, powdered oxalate of lime, before being heated, is not influenced by acetic acid, but dissolves, without effervescence, in mineral acids, and is precipitated from such solutions by ammonia.

To distinguish between the other substances mentioned above, put some of the powder into hydrochloric acid. It dissolves: (*a*) with effervescence, (*b*) without effervescence:—

(*a*) *Carbonate of Lime or Carbonate of Magnesium:*—

Carbonate of Lime.—The powder blackens under moderate heat; whitens under intense heat into caustic lime, which, when moistened with water, turns yellow-turmeric paper brown. The powder, also, without previous heating, effervesces freely in dilute acids.

Carbonate of Magnesium.—Dissolve the powder in dilute hydrochloric acid, neutralize the solution with ammonia, and dissolve the precipitate with acetic acid; add phosphate of sodium and ammonium, and the magnesia will precipitate as crystalline ammonio-magnesian phosphate in the shape of little stars or oblique crosses, the form of the crystals being due to the rapidity of the crystallization.

(*b*) *Oxalate of Lime or Phosphates:*—

Dissolves without effervescence. The powder is brought to a red heat and again tested with hydrochloric acid.	It dissolves with effervescence			. . . *oxalate of lime.*
	No effervescence follows, and the blowpipe is used.	Specimen fuses. Some of the unheated dust is treated with liquor potassæ.	Develops ammonia.	*Triple phosphate.*
			Develops no ammonia.	*Secondary* (*neutral*) *phosphate of lime.*
		Specimen will not fuse, and is *tertiary* (*basic*) *phosphate of lime* (bone earth).		

The Pathological Results of Urinary Calculus.

A comprehensive view of the relation which urinary calculus bears to structural alterations in the urinary passages, is obtained by simply recognizing the distinction between the two great divisions of stone, the primary and the secondary. The former are formed by the urine, often when the urinary organs are sound; the latter demand as an essential factor in their formation that the mucous membrane lining that portion of the urinary passage in which they appear, shall be in a condition of chronic catarrhal inflammation; consequently they only exist as a sequence of antecedent disease.

The primary stone, therefore, acting precisely like any other foreign body, may become the active agent of organic tissue-changes through the instrumentality of the process of traumatic inflammation, while the secondary stone is essentially little more than an excretion solidified by accident. It is indeed rather a symptom or result of previous disease than a malady; and although by its size and weight it may react upon the malady which caused it, and may become a traumatic factor increasing the intensity of that malady, yet it always continues to occupy a position second in importance to the original disease.

A knowledge of this fact is of value in prognosis. When a primary stone is removed from the urinary passages spontaneously or surgically, provided that no other stone remains and that the surgical removal has caused no serious damage, the disease is entirely cured. Not so, however, when a secondary (phosphatic) stone is removed. The patient is not well; one of his symptoms indeed has ceased, but the persistence of the cause which gave rise to that symptom (the secondary stone) may furnish the same symptoms (another stone) again. Consequently, the curative treatment of a patient practically begins after the extraction of his secondary stone, where in the case of extraction of a primary stone it virtually ends.

The only exception to this rule is the case where a secondary phosphatic crust forms about a primary nucleus, the latter having alone served as the efficient cause for the catarrhal condition in the presence of which the phosphatic deposit occurred. Here, the foreign body being removed, the chronic inflammation which it occasioned may and often does spontaneously subside.

In the kidney, a calculous infarction may lead to a cyst, but it rarely does so. A stone retained in the pelvis of a kidney may block the ureter and occasion acute congestion, suppression, uræmia—if the other kidney be diseased—and death. It may occasion hydronephrosis. It may grow enormously, distend the pelvis of the kidney, and cause atrophy of the secreting substance. It may give rise to pyelitis and catarrhal changes in the mucous membrane of the pelvis of the kidney, going on to calculous pyelitis, pyelonephritis, pyelo-nephrosis, or perinephric abscess.

At any point along the ureter a stone may be arrested in its passage, and partly or wholly occlude the tube. In such a case, in addition to the results of occlusion at the renal orifice of the ureter, the tube itself becomes dilated above the point of obstruction, ulceration of the ureter at the point pressed upon may occur, granulations arise, and hæmaturia with blood-casts of the ureter follow.

In the bladder, at first subacute and then chronic cystitis is caused by primary stone, leading ultimately to chronic vesical catarrh with secondary incrustation of the stone by phosphates. The chronic catarrh is marked by acute exacerbations, and may lead to extension of inflammation to the kidneys, and to all the sequences of a chronic cystitis.

In the urethra, a stone may lodge in the prostatic sinus, or behind any point of physiological or pathological (stricture) narrowing of the canal. There it may grow to a large size and cause catarrhal changes in that portion of the mucous membrane upon which it presses, and in the distended urethra behind it. Therefore its accretions in the end are phosphatic, whatever its primary structure may have been.

The foregoing remarks apply to calculi belonging to the primary group. All calculi forming outside of the urinary tract—sub-preputial, scrotal, perineal, in connection with abscesses and fistulæ communicating with the urinary tract—are secondary, phosphatic, and symptomatic of urinary contact with the products of chronic inflammation.

When such concretions, wherever situated, within or without the urinary channels, attain a certain size, they act locally as irritating foreign bodies, and increase the grade of the pre-existing inflammatory symptoms, together with the intensity of the subjective and functional phenomena to which these inflammatory symptoms give rise.

Stone in the Kidney.

All forms of urinary calculus are found in the kidney. The only indigo calculus on record was removed, after death, from the kidney. Urostealith has not yet been detected in the kidney after death, but of the four cases on record (Hunter's Museum, Heller, Moore, Vidau), in the second, Heller's, the patient complained of pain in the region of the right kidney, and passed all his small calculi by the urethra. This proof is circumstantial, but it is reasonably strong.

Secondary stone deposits occur in the kidney, but only as a sequence of pre-existing stone formation, or as an epiphenomenon in pyelitis, pyelonephritis, tubercle, cancer, etc., of that organ.

Renal nuclei usually pass on into the bladder. Those which do not escape from the kidney increase in size. They remain smooth and oval while small, and may continue in this condition while they grow, unless the pelvis of the kidney passes into a condition of chronic inflammation. In this case, alkaline deposit forms either spontaneously or upon the nucleus already at hand, and such secondary stones are liable to attain large size and to assume a branched form, extending into the calices and down into the mouth of the ureter. They often still remain oval, even after becoming phosphatic. A branching kidney stone, however, is not necessarily phosphatic. Melchior Torrés[1] reports a large renal calculus, thoroughly branched, weighing over an ounce (37 grammes), and composed almost entirely of uric acid with a little urate of ammonium and oxalate of lime. This stone seemed to have formed as the direct result of an injury. A stone in the kidney, on the other hand, may reach enormous dimensions and retain its rounded form, not being in the least branched. Such was the large specimen obtained after death by MacGregor, and already referred to. This stone has never been chemically examined, but, although apparently covered with a layer of phosphates, it is undoubtedly an acid (primary) stone. Its weight is 51 ounces.

The symptoms of stone in the kidney (hæmaturia, nephralgia, irritable bladder, reflex pains), its spontaneous escape (nephritic colic), its results (calculous pyelitis, hydronephrosis), its surgical removal (litho-nephrotomy and nephrectomy), have been considered in a previous article.[2] It must not be forgotten that stone may remain for years in the kidney without producing any symptom, and may be accidentally discovered after death.

Stone in the Ureter.

There is no reason to believe that stone ever forms primarily in the ureter, and, as a rule, any calculus which fairly passes into the mouth of the ureter sooner or later works through and enters the bladder. The length of time required for this passage, in my experience, varies from a few minutes to many months. In one instance, a patient regularly had a paroxysm of nephritic colic on the same day of the week for several successive weeks, being without pain on the other days, until finally his stone passed. In another instance, a gentleman was treated by a homœopathic physician for what was called hernial colic (the patient wore a truss), during an entire winter. Under the use of alkaline diuretics, an acid stone which had been arrested during all this time at the vesical end of the ureter, was voided.

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[1] Bull. de la Soc. Anat. de Paris, t. iii. p. 90. 1877.

[2] See Vol. V., page 1075, *supra*.

Both ureters may be plugged simultaneously, sometimes with single, sometimes with multiple calculi.[1] The distressing symptoms and high mortality recorded for cases of calculous anuria are well known. Reliquet[2] quotes Merklen's statement that out of fifty cases there were only nine cures. He proposes as a means of relief an increase of the blood pressure by a simultaneous elastic constriction of both lower extremities with elastic bands. Aided, seemingly, by this means, one of the two cases in which it was tried ended in recovery. The suggestion is due to Prof. Bouchard. The constriction may be repeated daily, and the bandages may be left in place until difficulty of breathing and general physical distress make their removal imperative.

If, instead of passing out or causing complete anuria, the calculus does not absolutely occlude the ureter, then the urine trickles along side of it, and it ultimately sets up catarrhal inflammation in the ureter, and becomes a phosphatic stone with acid nucleus. Or the calculus may form a pouch for itself, a sort of sacculation, as in a case shown by Norman Moore to the London Pathological Society.[3] The specimen was removed after death. The pouch had become surrounded by a large deposit of fat, which Moore believed to be due to irritation.

Total suppression due to calculus impacted in the ureter has caused a number of deaths in persons from whom one kidney has been removed. So positively has this fact been observed that it has been brought forward as a reason why nephrectomy should not be performed. I have personal knowledge of one death from this cause.

The symptoms of impacted stone in the ureter vary. There has generally been prolonged nephritic colic, without the passage of the stone. There is always, at first, partial anuria, complete if both ureters are plugged. More or less pain is felt about the region of the kidney on the affected side. There is often a dull pain in the groin, and more or less in the testicle of the same side. There may be considerable or very little irritability of the bladder, with some pus and blood in the urine. Localized tenderness, increased by manipulation, often marks the point in the ureter at which the stone lies. This point is usually near the upper or the lower outlet of the tube.

Treatment.—When a stone is stopped in a ureter, it is to be presumed that the methods employed for the relief of renal colic have failed—such as hot baths, diluents, opiates, diuretics, electricity, external manipulation, cups to the loins. Should there be complete calculous anuria, these methods should be persisted in with renewed energy, and Reliquet's plan of simultaneous elastic compression of both lower extremities should be tried. Along with this, Reliquet recommends repeated rectal injection of small quantities of iced water. A little pilocarpin might be cautiously tried subcutaneously ($\frac{1}{12}$–$\frac{1}{8}$ grain), to which might be added the copious use of Bethesda water or light beer. Modern surgery has further placed at our command more radical measures which should always be tried before it is too late, when a positive diagnosis can be made.

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[1] Fatal case with autopsy. H. Haehner, Berlin. klin. Wochenschrift, 12 Sept. 1881, S. 531.

[2] Anurie calculeuse, etc., Note lue à la Soc. de Méd. de Paris, 11 Fév. 1882. (Extrait de L'Union Médicale, 3ème série, 23 et 25 Mai, 1882.)

[3] Lancet, March 25, 1882, p. 482.

A brilliant innovation of modern surgery is nephrolithotomy for calculous anuria. Dr. Thelen,[1] of Cologne, has described a successful case, Bardenheuer being the operator. Czerny first suggested the performance of nephrolithotomy. H. Morris[2] first performed it, but not for obstruction; his case was one of kidney stone without suppression.[3] In Thelen's case the patient had had left suppurative pyelitis and perinephric abscess. Through an incision made into this abscess the kidney was felt to be entirely atrophied. Suddenly, during convalescence, complete suppression came on. Bardenheuer thereupon exposed the other ureter in the flank, found in it a calculus as large as a bean, firmly impacted, liberated the calculus by a longitudinal incision, and sewed up the ureter. After temporary relief, a severe chill and high temperature caused Bardenheuer to reopen the wound, cut the ureter, and bring out its proximal end into the wound. A month afterwards the patient was doing well, urinating through the wound.

Sometimes a stone, reaching the vesical orifice of a ureter but not entirely obstructing it, will grow by phosphatic accretion, and finally find its way into the bladder by ulceration, or it may prolong itself into the bladder. Sometimes a vesical stone grows into the ureter.

PROSTATIC STONE.

Two forms of concretion may be encountered in the prostate and its sinus, the true prostatic concretion, and urinary calculus. The former will receive consideration in another article.[4]

Primary urinary calculus does not form in the prostate. An acid nucleus or fragment may lodge in the sinus, and for a time increase as an acid stone. But sometimes nuclei detained in the prostate grow by the addition of layers mainly composed of phosphate of lime—in this way coming to resemble true prostatic concretions. There are five methods by which urinary calculus may form in the prostate.

1. A nucleus from the kidney may become arrested there and grow.

Ebel[5] relates the case of a boy who, at the age of three, commenced to suffer from urinary discomfort and occasional attacks of retention. This persisted for six years, until a bean-sized stone was removed from the prostatic sinus by a cutting operation.

2. A fragment after lithotrity may behave in a similar manner.
3. A true prostatic concretion, reaching a certain size, may ulcerate its way into the prostatic sinus and continue to grow, a pure phosphate-of-lime prostatic calculus, as in Mastin's[6] case. Or it may receive accretions of urinary salts and grow backward into the bladder, reaching considerable dimensions—prostatico-vesical calculus.
4. A vesical calculus may send a prolongation forward into the prostate, vesico-prostatic calculus.
5. An abscess in the prostate may leave a pouch in which urine accumulates, decomposes, and gives rise to a calculus. The same thing may happen in the fistulous tracts left by burrowing abscesses, and after lithotomy.

Stones in this region attain great size, and may ulcerate their way outwards into the scrotum, perineum, or rectum. A large phosphatic calculus which presumably had been carried by the patient for fifty years, and had made a nest for itself in the perineum and prostate, was removed by Walton.[1] Its diameters were two and a half inches by one inch. Many other cases will be found included under the head of *urethral calculus.*

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[1] Centralblatt f. Chir., 25 März, 1882, S. 185.

[2] Lancet, Oct. 30, 1880, p. 698.

[3] Up to May 23, 1884, eight cases of pure nephrolithotomy, all told, had been performed without one death. (Lancet, May 31, 1884, p. 983.)

[4] See article on Injuries and Diseases of the Bladder and Prostate, *infra.*

[5] Mag. f. d. ges. Heilk., Bd. xlviii. S. 271. 1837.

[6] Medical News, August 16, 1884, p. 175.

Symptoms.—Prostatic stones, even when very small, may give rise to much annoyance; yet the parts sometimes acquire surprising tolerance of the foreign body, and the calculus may be first revealed during an autopsy. I find two cases in which large prostatic calculi were perforated by a natural channel for the escape of urine. One of these calculi, removed by Rushton Parker,[2] weighed an ounce and a half. It seemed to replace the prostate, and had a central perforation. The other, observed by T. Sympson,[3] had two channels widely separated from each other. It was a vesico-prostatic calculus.

The actual symptoms of prostatic stone are a varying amount of pain, weight, heat, dragging, throbbing in the perineum and rectum—possibly abscess, irritability of the bladder, retention of urine, presence of more or less pus and blood in the urine, erotic desires and a tendency to priapism—or there may be practically no symptoms at all. A searcher can generally be made to enter the bladder with ease, and diagnosis is established by the grating sound and confirmed by rectal touch.

Treatment.—If the stone is small and has recently lodged in the prostatic sinus, an effort should be made to push it back into the bladder with a large, blunt, steel sound, or by passing a hollow tube up to the stone, and rapidly injecting a large amount of warm oil through it while the urethra is kept compressed about the tube. If these means fail, an attempt may be made to crush the stone with a small urethral lithotrite, or to extract it with the long urethral forceps or a Thompson's divulsor, as recommended for urethral calculus. Failing in this, and in all cases of large stone, a perineal incision is required—in the median line for stones of moderate dimensions; lateral or bilateral incision for stones of very large size.

URETHRAL CALCULUS.

It is not probable that primary acid stone forms in the urethra. Secondary alkaline stones do originate there in ulcerated pouches, behind tight stricture, in cavities left by abscesses, and perhaps in dilated follicles with narrow mouths. Commonly, urethral stone forms upon a nucleus sent down from above, a kidney-stone, or a fragment left after lithotrity. In young children a kidney-stone on its passage is often arrested in the fossa navicularis, or at the meatus; in older persons, in the more sensitive membranous urethra. Here it remains grasped by the muscular urethral walls, and grows by the addition, first of uric acid, and afterwards of phosphates. Ulceration may ensue and the stone find its way out spontaneously (Civiale).[4] How long urethral stone may be carried is uncertain. In a case recorded by Block,[5] such a stone was extracted after a sojourn of twenty-eight years. Urethral stone may be single or multiple to any extent; particularly is urethral calculus multiple when the floor of the urethra communicates with a pouch beneath. I have encountered this condition once, extracting five phosphatic stones.

The size which urethral calculus may reach, and other points connected with the subject, may be illustrated by briefly citing some curious cases. Zeissl[6] has collected a number of these, among them Wattmann's case, that

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[1] Trans. Path. Soc. Lond., vol. xiii. p. 143. 1862.

[2] Brit. Med. Journ., vol. i. p. 85. 1878.

[3] Ibid., vol. i. p. 413. 1878.

[4] Op. cit., p. 607.

[5] Acta Acad. Nat. Curios., tom. viii. p. 441. Norimbergæ, 1748.

[6] Ueber die Steine in der Harnroehre des Mannes. Stuttgart, 1883.

of a man of 80, who passed in all 300 stones by the urethra. Pulido's scrotal stone, weighing 23½ ounces, taken out by incision through the scrotum; the patient recovered with fistula. Rathelot's urethral stone of 60 grammes, removed by incision, fistula remaining. Græfe's scrotal stone of 26 ounces, which escaped spontaneously while the patient was making a straining effort. Ulecia's case of an 80-gramme stone removed by incision. Civiale's case of the old man whose bladder and urethra were so full of stones that no one had the patience to count them. Voillemier's stone of 2 ounces 6 drachms, which filled the entire urethra from the meatus to the membranous portion, being composed of several segments. Camper's 5-ounce stone cut from the membranous urethra. Maigrot's stone of nearly 8 ounces, cut from the membranous and prostatic urethra by the bilateral operation, with fatal result. Da Luze's 20½-ounce scrotal stone. Heath's cystine stones, and many others of interest.

Vanzetti[1] tells of a Russian, who at the age of one year passed a kidney-stone which became arrested in the fossa navicularis, and ulcerated its way through the floor of the urethra. In its sac, which did not communicate with the preputial cavity, it grew for eighteen years, and when removed consisted of one large and many small calculi, weighing collectively 224 grammes, more than seven ounces.

Bellamy[2] removed two phosphatic calculi weighing one ounce, from a sac beneath the urethra just in front of the scrotum in a man of forty. The sac was incised and a small orifice of communication was found between it and the urethra. The patient recovered without fistula. Walton[3] refers to another such sub-urethral sac connected with the spongy portion of the canal. It contained 146 calculi, and is now in the Museum of St. Bartholomew's Hospital. Kerr[4] gives another case, where a similar sac was found to contain 291 calculi, four of which were as large as pigeon's eggs. This patient was 21 years old, and had carried the sac from birth.

Symptoms.—The symptoms of urethral calculus vary with the position of the stone. A very small stone in the membranous urethra may cause partial or entire retention of urine by exciting permanent spasm of the "cut-off" muscles. I have recorded a case[5] where retention, over-distention, and overflow ensued from this cause. Impacted calculus at the meatus may also (but rarely) cause retention, and calculus impacted in a tight stricture may do the same. Otherwise urethral stone causes irritation, gleet, irritability of the bladder, tendency to erection, pain on erection, general inflammatory phenomena, etc., more or less intense, according to the position and size of the stone and the general condition of the patient. In front of the penoscrotal angle, or at any part of the canal, if the foreign body be large enough, it may be felt from the outside.

Diagnosis, in doubtful cases, is made by touching the stone with a probe or sound introduced through the meatus.

Treatment.—A urethral calculus, when small and round, may be washed out of the canal by causing the patient to drink freely of mild, diluted drinks, or even of gin or beer. The patient should be instructed to hold his urine as long as possible; then he should receive a small, subcutaneous dose of morphine or a dose of chloral, take a very hot bath, pass his water freely in the bath, and, when the stream is under full headway, arrest it suddenly by compressing the urethra, without relaxing the effort at urination, and then immediately allow the stream to continue its flow. This sudden distention of the urethra will often dislodge a small stone. If such a small stone lies behind the bulbo-membranous junction, it is better to push it back with a large, blunt, steel sound into the bladder, whence it may be afterwards washed out through a tube or crushed. Or it might be washed back into the bladder by injecting warm oil through an open tube passed down to it. If it can be felt in or anterior to the perineum, March's[1] expedient may be employed. This consists in passing a very large blunt steel sound up to the obstruction, and then, by external manipulations upon the calculus alone, to push out at the same time both it and the sound; the latter, of course, maintaining an open urethra as it goes.

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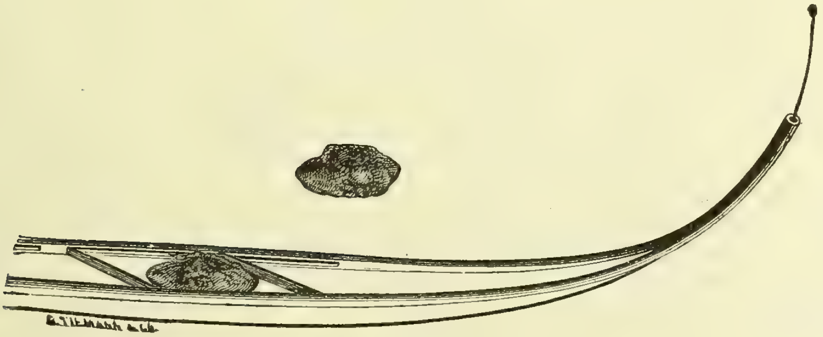
[1] Bull. de la Soc. Anat. de Par., t. xix. p. 16. 1844.
[2] Trans. Clin. Soc. Lond., vol. xi. p. 22. 1878.
[3] Trans. Path. Soc. Lond., vol. xiii. p. 43. 1862.
[4] New York Med. Journal, vol. xv. p. 283. 1872.
[5] Med. Record, March 6, 1875.

This is very similar to the expedient first suggested by Averill, that a large sound should be carried down to the stone, and, while the patient made a continued effort to urinate, the sound should be withdrawn that the stone might more easily escape through the distended urethra.

When the stone is large, rough, angular, or lodged behind a constriction, these means do not suffice. It must then be extracted with forceps, or the urethra must be incised. I have not found the urethral lithotrite of service, but believe that it might be available in a case of prostatic stone. Leroy d'Étiolles's scoop, the crocodile forceps, and the long urethral forceps, in my hands uniformly scrape, pinch, or tear the urethra, and I no longer use them.

The best instrument in my experience for extracting foreign bodies from the urethra has been Thompson's divulsor, designed for splitting strictures. My first success[2] was upon a physician in whose membranous urethra a rough oxalate-of-lime calculus had been lodged for two months, causing repeated retention of urine, vesical distention, and overflow. The accompanying figure shows the stone in position as it was caught and extracted. The diameters of this calculus were $\frac{1}{2}$ and $\frac{5}{16}$ inch. The whalebone guide slipped easily past it, and the tunnelled divulsor followed without difficulty. The blades were separated, and, on being approximated, caught the stone and extracted it with ease. I found afterwards that this expedient had been previously resorted to with success by Dr. Westmoreland,[3] of Georgia. Subsequently I removed[4] a pin from the deep urethra of the male with the same instrument, and without any difficulty. A divulsor with one cross-bar is preferable to those which have two.

Fig. 1198.



Extraction of urethral calculus with Thompson's divulsor.

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[1] Trans. New York State Med. Soc., p. 71. 1867.
[2] New York Med. Record, March 6, 1875.
[3] Atlanta Med. and Surg. Journ., Oct. 1874, p. 415.
[4] New York Med. Record, May 1, 1875.

In trying to remove an angular fragment with any instrument, there would be great risk of tearing the urethra, and in any such case, or where the stone is quite large, a single, clean, free, longitudinal incision of the urethra at the site of the stone is probably better than other methods.

Such incisions heal rapidly if kept clean, and never, in my experience, yield fistulæ. All that it is necessary to do, even when the cut is extensive, is, if the urine be ammoniacal, to inject a little warm water through the urethra, letting it pass out by the fistula after each act of urination, when the healing process is approaching its termination. If the urine be normal, no such precaution is usually necessary. All encysted urethral stones require treatment by external incision, and the wound must be handled afterward according to general surgical principles. There is a liability for fistula to remain in these cases when the urethra is much thickened and chronically inflamed at the position occupied by the stone.

PREPUTIAL CALCULI.

Sub-preputial calculi are common in China. In Europe and America they are rare. Among 15,000 patients examined by Albers,[1] in 1835, only one case of preputial stone was found; while Lewin,[2] among 35,000 hospital patients examined during fifteen years, found only three cases. Kerr,[3] on the other hand, declares that the affection is not uncommon in China, and gives a table of 18 personal cases.

This malady is encountered at all periods of life. Uncleanness and a tight prepuce are prime factors in its production.

The efficient causes are three: (1) calcification of smegma; (2) retention of a small renal or vesical stone passed from above; (3) ammoniacal degeneration of urine retained within a tight prepuce.

(1) *Calcified Smegma.*—Every one who has removed from a child a tight, adherent prepuce, has noticed the little white rolls of smegma imprisoned behind the corona glandis. If these masses are retained long enough they acquire considerable size, cause the prepuce to inflame, and, finally, calcify more or less completely. They may subsequently act as nuclei for the precipitation of urinary salts out of urine retained in the preputial cavity. Salkowsky and Zahn have examined these concretions, and have found fat, fatty acids, lime salts (but no uric or phosphoric acid), epithelium, cholesterine, and bacteria.

(2) *Retention of a Small Urinary Stone.*—This occasionally happens, but is exceptionally rare, because any stone that can pass the meatus urinarius can, as a rule, also escape at the preputial orifice. It may lodge, however, and then becomes a nucleus for further calculous deposit.

(3) Most common among the causes of preputial stone is *tightness of the preputial orifice* and consequent retention within its cavity of a few drops of urine. This residuum decomposes, and deposits triple-phosphate crystals and earthy-phosphatic dust in a magma of mucous colloid, and deposits continue from new portions of urine until stones of considerable size may be formed.

The composition of preputial calculi is ordinarily a little urate of ammonium and much triple and earthy phosphate, with a great deal of mucus. They are generally multiple. The least number found in any of Kerr's cases was two; the greatest number, 116. They are usually facetted and queerly fitted into each other and about the glans penis, being often laminated and concavo-convex in shape, sometimes capping the glans penis, and perforated to allow the passage of urine.

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[1] Journ. der Chir. und Augenheilkunde, Bd. xxiv. S. 247. 1836.

[2] Ueber Præputialsteine, Berl. klin. Wochenschr., Bd. xvi. S. 177 und 197. 1879.

[3] New York Med. Journal, xv. p. 283.

In size these calculi vary from a minute cluster of crystals up to concretions as large as an egg. In one of Kerr's cases they weighed one ounce two drachms and two scruples, and Bardeleben[1] refers to a stone reported by Duméril, which weighed two hundred and fifty-five grammes—about eight ounces. This sounds improbable. No reference is given, and I have been unable to find the original report. Civiale[2] speaks of a young man of twenty, with phimosis, who, after practising coitus for the first time, experienced pain and a purulent discharge. Civiale removed five stones as large as prunes. These had been felt by the patient, but he had supposed that it was perfectly natural to have them.

The results of subpreputial stone are disturbance in the function of the penis, atrophy of the glans, and more or less ulceration and inflammation within the preputial cavity.

The symptoms are hard lumps felt beneath the prepuce, more or less pain, purulent discharge, interference with urination and coitus, involuntary pollutions—in some cases, finally, impotence.

The *treatment* consists in ablation of the prepuce with the calculi.

Umbilical Calculi.

Scattered instances are encountered of cases in which a calculus has been extracted or spontaneously voided from the umbilical region, a calculus presumably formed in a pervious urachus, or a kidney-stone that has found its way out through this strange channel. Umbilical stones are generally phosphatic.

Among the classical cases may be mentioned that of Boyer, who took twelve calculi out of a patulous urachus in a man of twenty-six, and that of Thomas Paget,[3] of Leicester, who removed, from the patulous urachus of a patient, a ring-like, phosphatic concretion with a hair for a nucleus. Another case, in a man of forty, is reported by H. C. Stewart.[4] The calculus is called phosphatic, and described as being as large as a hazel-nut. H. D. Vosburg[5] reports the case of a mechanic of fifty, from whose umbilical region a phosphatic stone as large as a hickory-nut was voided. A similar stone had been passed by the man in the same way twenty years previously. These records, and those of J. Dixon[6] and several others, generally make no mention of urinary symptoms. The complaint is of local discomfort, the inflammatory swelling is obvious, and the foreign body is palpable. The latter seems fully capable of discharging itself under poulticing, and recovery follows.

Urinary Calculi outside of the Urinary Tract.

Wherever urine may trickle through a fistulous track, secondary urinary calculus may form, composed of triple and earthy phosphates, mixed often with some urate of ammonium. Stones also, starting within the urethra, may by ulceration get into the scrotum, perineum, or elsewhere, and increase enormously as outside stones. Civiale[7] speaks of a stone taken from the scrotum of a boy of eighteen, which was three inches long and one inch in circumference centrally. Lippoman[1] records the case of a man of sixty-eight, who, fifteen years previously, had had a scrotal stone, weighing one hundred and twenty grammes, removed by incision. A fistula remained. New stone formation occurred, and Lippoman took out four phosphatic calculi, weighing forty grammes, as large collectively as a goose-egg. Louis[2] refers to an enormous perineal stone, weighing ten and a half ounces, removed by M. de Gaigneau from a patient of fifty-eight, who had been cut for a stone at the age of eight, and was known to have carried his perineal stone more than twenty years. In the same article he quotes a most remarkable case from a dissertation by Denys de Launay, printed in 1700. Five years after lithotomy, a large stone escaped spontaneously from the perineum of the patient, and was discovered in his bed. The surgeon who was summoned, it is related, then and there, through the same opening, withdrew from the bladder a stone which weighed seventeen ounces.

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[1] Lehrbuch der Chirurgie, 7te Ausgabe, Bd. iv. S. 354.

[2] Op. cit., p. 560.

[3] Med.-Chir. Trans., vol. xxxiii. p. 294. (See Fig. 1114, Vol. V., p. 970, *supra.*)

[4] Lancet, vol. ii. p. 294. 1849.

[5] Lond. Med. Repository, N. S., vol. i. p. 291. 1824.

[6] Ibid.

[7] Op. cit., p. 589.

Amussat[3] records another case of spontaneous exit of vesical calculi in front of the scrotum. The patient was thirty-three years old, and had suffered for twenty years previously from urinary symptoms; the stones had ulcerated their way through the skin, and were pressed out by the surgeon. There were two stones fitted together, collectively one by two inches in diameter. It is narrated of this patient that, up to a short time before the spontaneous exit of the stones, he had urinated and performed the sexual act naturally. He got well without a fistula. Alex. Patterson[4] reports a case of perineal stone following a traumatism. The patient removed an ounce with a chisel, and the rest of the stone, weighing 14½ ounces, came away spontaneously.

Vaginal calculus is a similar instance of outside stone formation. Herbert Cole[5] describes two such calculi taken from the vagina of a child of eight, one of which had a button for a nucleus. The total weight of these mixed phosphatic stones was four ounces. The floor of the urethra had sloughed. J. G. Wilson, of Glasgow,[6] speaks of a uterine calculus, discovered and removed during labor, and believed to have been due to vesico-uterine fistula. The secretary of the Edinburgh Obstetrical Society reports another precisely similar case in the same journal. In neither instance was the fistula seen. Old medical writings contain numerous references to uterine calculi, most of which are undoubtedly examples of calcareous tissue change.[7] I have removed, by lithotomy, a large phosphatic calculus which had collected in the vagina of a lady who had suffered from vesico-vaginal fistula, and whose vulva had been nearly closed to create a reservoir for the urine.

The cavities of abscesses in the pelvis, perineum, and thighs, which communicate with the bladder, often contain more or less phosphatic calculous material.

Thus it will be seen that after lithotomy leaving a fistula, in cases of abscess or wound communicating with the bladder, or in connection with a stone ulcerating its way out, phosphatic calculous material is quite sure to precipitate in any situation outside of the bladder.

The *symptoms* of such stones vary with their position and size.

The *treatment* is removal and operative closure of the vesical end of the fistula, when practicable.

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[1] Wratschebuyja Wedomosti, No. 454, 1881 ; and Centralblatt f. Chir., 23 April, 1881.

[2] Mém. de l'Acad. Roy. de Chir., t. iii. p. 332.

[3] Rev. de Thérap. Méd.-Chir., p. 372. Paris, 1869.

[4] Glasgow Med. Journ., June, 1884, p. 409.

[5] Lond. Med. Reposit., vol. viii. p. 109. 1817.

[6] Edinb. Med Journal, vol. viii. p. 92. 1826.

[7] An interesting article by Louis, with ample references to previously reported cases in this line, is found in the Mém. de l'Acad. Roy. de Chir., t. ii. pp. 130–150. Paris, 1753.

STONE IN THE BLADDER.

The frequency of stone in the bladder, the serious discomfort which it occasions, and the brilliancy and success of the various operations for its removal, have made it a subject of great interest to surgeons. The ingenuity of man has taxed itself to devise cunning instruments, monuments of mechanical skill, and to plan out bold operations for the relief of this painful disorder, and probably no field in medicine or surgery has furnished a fairer harvest for the quack.

POSITION OF STONE IN THE BLADDER.—A small calculus in a healthy bladder lies at the neck of the organ when the latter is empty, and, during distention, rests upon that portion of the bladder which is most dependent. The stone is freely movable, and consequently shifts its position with the varying posture of the patient. This change of position helps to explain the symptoms, relief during repose, aggravation by exercise when the foreign body is rubbed against the bladder's most sensitive portion, its neck.

When the prostate is much enlarged, the stone habitually rests in the *bas-fond* behind it, and does not, in any ordinary position of the patient, ever touch the neck of the bladder except when the bladder is empty. In this way an old man may carry a small stone without suffering any of the customary symptoms. Such stones are frequently first detected by accident. When the bladder is sacculated, a stone may lodge in one of the pockets. Calculi, indeed, may form in these pockets and never leave them, thus becoming encysted stones, or the stone may lie partly within and partly without a pouch. A bilobed bladder may contain a stone[1] which may occupy the cavities alternately. A vesical tumor may fix the position of a stone. A calculus may form and remain in an abscess-cavity in the walls of the bladder. A stone may be adherent to an ulcerated surface, or to a tumor, or may be fixed by partial impaction in the orifice of a ureter, or of the urethra.

A stone may sometimes be retained by contraction of certain parts of the bladder-walls about it, thus being held behind the pubis or at the fundus, there being no true adhesion.

Encysted Calculus.—This variety generally commences as a sacculated stone, which, growing by concentric accretions, distends its pouch to its utmost capacity, the stone becoming larger than the mouth of the pouch. Such a stone may become hour-glass-shaped, for, after it has completely filled the pouch, it grows by deposit upon the exposed part presenting toward the bladder, and thus growing becomes in shape like a dumb-bell with a narrow neck. Such stones cause obscure symptoms and are often difficult to remove.

When a stone in the bladder is very large, its position does not change. It becomes oval, and perhaps sends prolongations into the ureters and urethra; the thickened and inflamed wall of the bladder embraces it upon all sides and the urine trickles away, there being perhaps true incontinence. Such stones may be easily felt by the finger in the rectum.

Adherent Calculus.—The possibility of the adhesion of a calculus to the vesical mucous membrane has been denied. It is certainly not as common as might be inferred from reading reports of cases of lithotomy, for it is not very exceptional to read that the stone adhered to the bladder and was extracted with considerable difficulty.

Undoubtedly this hypothesis is frequently suggested by difficulty in extracting a stone, especially if a rough side of the stone happens to come out covered with a blood clot. But adhesion does occur in two ways: (1) crystalline deposits form upon an eroded surface and are entangled in long granulations; and (2) the pressure of a rough stone may so irritate the mucous membrane that granulations form and entangle themselves among the irregularities of the stone.

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[1] Case of Scarenzio, quoted by Gross (op. cit., p. 190).

T. G. Morton[1] reports an operation for removal of a phosphatic calculus of one hundred and sixty-five grains, which was firmly attached by a long pedicle to the top of the bladder. All doubt about the adhesion of stones has been removed by evidence furnished at autopsies—such as the following:—

A woman[2] of 50 died at the Middlesex Hospital, England, of uterine and ovarian cancer, having no symptoms of stone. A vesical calculus was found after death, a "flat scale or lamina about half an inch in diameter, situated at the base of the bladder about an inch from the opening of the urethra." It reposed upon an ulcerated area, and minute shreds of tissue could be seen passing into the concretion which was composed mainly of phosphate of lime and crystals of oxalate of lime. Mr. Nunn[3] reports an example of adherent stone, as large as a nutmeg, composed exteriorly of uric acid and phosphates, and found in a dead-house case. The stone was attached just behind the prostate. Finally, another post-mortem case is related by F. Powell.[4] It occurred at the Necker Hospital, Paris, and Civiale exhibited the specimen to his class. The stone was phosphatic, projected three-quarters of an inch into the bladder, and had formed upon an ulcer at the base of the bladder, being firmly attached to the muscular coat.

I have encountered adherent stone only once, and this was a thin layer mixed with granulations on the back wall of a bladder in a patient whom I cut by the median operation, and from whom I extracted a small phosphatic stone. To remove the adherent laminated stone, I was obliged to use considerable force, and to scrape the mucous membrane bare, removing both granulations and débris of stone. The patient made a good recovery under injections acidulated with dilute nitric acid. When a stone is adherent, the symptoms it occasions are usually obscure and generally more like the symptoms of severe chronic cystitis than like the classical symptoms of stone.

SYMPTOMS OF URINARY CALCULUS IN THE BLADDER.—There is no symptom, no set of symptoms, absolutely and invariably pathognomonic of the existence of stone in the bladder, except the physical sign furnished by touching it directly or with an instrument. All so-called symptoms may be present without stone. On the other hand, there is no ordinary symptom of calculus which may not be absent in a given case, and perhaps all of them may fail, and the stone elude even a skilled searcher.

A certain grouping of symptoms, however, is very suggestive of the presence of stone. These symptoms are:—

1. Frequency of urination, greater by day than by night, aggravated by exercise, especially by jolting, and sometimes amounting to incontinence in children, or even in an old patient with a large stone, or when a portion of the stone grows into the urethral orifice.
2. Hæmaturia, especially after exercise.
3. Sudden stoppage of the full stream of urine, attended by pain and a desire to strain.
4. Pain, sometimes referred to the rectum or perineum, more often to the meatus urinarius, or, especially in the adult, to a point on the under surface of the urethra, about three-quarters of an inch from the meatus.

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[1] Penna. Hosp. Reports, p. 49. 1869.

[2] Van der Byl, Trans. Path. Soc. Lond., vol. ix. p. 296. 1857–1858.

[3] Med. Times and Gaz., vol. ix. p. 579. 1854.

[4] Ibid., vol. ix. p. 528. 1854.

5. A tendency to pull at the end of the penis, especially in children and young adults, a habit which leads to permanent elongation of the prepuce in the former, and to masturbation in the latter.

6. Pus or stringy mucus in the urine.

7. Intense straining with severe pain during and after each act of urination, a pain often of agonizing intensity. These paroxysms exhaust the patient's strength, and during them he resembles a woman in the third stage of labor. In children, prolapse of the rectum is a common result of this straining, with fecal evacuations during the paroxysms, while adults complain of hemorrhoids, pass blood by the rectum, and during the paroxysms suffer from unavoidable escape of intestinal flatus, and often of feces. The paroxysms vary in intensity and duration.

8. Reflex pains in the back, testicle, thigh, and not uncommonly in the sole of the foot (pododynia).

9. Priapism with, or more often without, sexual desire.

10. All the symptoms of chronic catarrh of the bladder, especially in the case of secondary (phosphatic) calculi.

Should several of these symptoms coincide in a given case, a suspicion of calculus is justified, but they may all occur when there is no stone, and stone may be in the bladder without furnishing any of these symptoms, while nothing is more common in old men than for the presence of stone to be masked by the ordinary symptoms of catarrhal cystitis accompanying enlarged prostate.

Young people, as a rule, suffer more from stone than old ones. Their symptoms are generally more obvious, and an error of diagnosis from lack of symptoms is not likely to occur. With adults this is not always the case.

I extracted by lithotrity a calculus larger than a pea from a gentleman who had passed it into his bladder during an attack of nephritic colic two months previously, and had not been inconvenienced by it in any way until a few days before applying to me. In many instances I have removed primary smooth stones of considerable size where the patients have been positive that their symptoms only dated back a year or more, while a careful cross-questioning has been able to place the date of origin of the stone a number of years before, at some well-remembered attack of marked nephritic colic not followed by an escape of stone from the urethra.

In one case a gentleman applied to me for relief from slight irritability of the bladder, of recent occurrence. His urine was heavy, contained crystals of uric acid, and a few pus-cells. An alkaline diluent was ordered, and he was relieved and believed himself well. After many months frequency of urination recurred, and then a search revealed the fact that the bladder was full of small calculi. I washed out six of these, as large as peas, through a Bigelow tube in my office, and felt many more larger ones rattling against it. This manœuvre so relieved the patient that he pronounced himself well, and declined to submit to further instrumentation, and this in spite of my strongest assertions that the bladder still contained stone. He simply declined to believe it, although I had felt them and made him hear the sound.

A youth of about 18, with a congenitally long, tight prepuce, intensely nervous, and a masturbator, applied to me, complaining that he passed water too often, and was obliged to pull upon the penis and scratch the under surface of the urethra and the perineum during and after the act of urination, and to practise masturbation. He had no pain, no tenesmus, nor other symptom. The urine was not perfectly clear, but was no more purulent than might be expected in one who habitually urinated too often. As a first and necessary step in the case, I suggested circumcision. This was done, but no improvement followed. The patient was then searched, and a stone over an inch in diameter found and removed.

No old man with prostatic hypertrophy and catarrhal disease of the bladder should be allowed to go unsearched for stone, whether he has the so-called symptoms of stone or not. In such cases there is very often no symptom present which could not be accounted for equally well by the catarrh of the bladder and the prostatic hypertrophy. But in these cases, when stone is found, its removal greatly comforts the patient, although it may not absolutely cure him. But to return to a specific consideration of the separate symptoms, any of which may be caused by stone, and the association of which is nearly pathognomonic.

1. *Frequency of Urination more marked by Day.*—This symptom is quite constant—except in the case of old men with prostatic enlargement. The latter almost uniformly causes nocturnal frequency of urination, and the presence of one or more small stones in the residual urine may not modify this symptom. Such a patient will urinate more often by night than by day, except during occasional exacerbations of the cystitis—"attacks of the stone"—when the intervals by day will probably be shorter than they are by night. The stone in these patients never touches the neck of the bladder.

This rule does not hold good when in cases of enlarged prostate there is no residual urine, nor in any case where the stone is large. Here the diurnal frequency of urination is more marked. A reason for this is not far to seek. When there is no *bas-fond* behind the prostate, the floor of the bladder is about on a level with its neck, and, when the patient is erect and moving about, the stone rolls against the neck of the bladder and irritates this sensitive part. During urination, also, the stone is driven against the vesical orifice, and the tenesmus after urination—a blind effort on the part of nature to get rid of the cause of annoyance—mercilessly grinds the stone against the most tender part of the bladder. This is especially the case in young children.

An irritation, even a cystitis, about the neck of the bladder, is in this way produced, and is mechanically aggravated by the movements of the stone during the day, while rest at night gives the tender vesical orifice a certain respite.

Considerable cystitis, even an ulcer,[1] may exist at the fundus of the bladder with no frequency of urination to announce its presence; but not so if the inflammation involves the neck of the bladder. In the latter case, urination is invariably too frequent, and especially so by day while the patient is conscious of his sensations, and more particularly if he be moving about. With an enlarged prostate, residual urine, and a *bas-fond* behind the prostate in which the stone reposes, exercise does not rub the stone, if it be small, against the neck of the bladder, and urination does not raise it high enough to touch the neck of the bladder at all; consequently the old man may continue, as is the wont of prostatic patients, to urinate too often by night, not being much annoyed by day except during the paroxysms of aggravation of the cystitis, when the inflammation spreads to the vesical neck. Then the patient has "an attack of the stone." It is obvious why in irritability of the bladder (neuralgia), ordinary cystitis complicating stricture of the urethra, acute prostatic disease, etc., urination should be more frequent by day than by night, although the patient has no stone; for in these cases the neck of the bladder is in a state of irritation, and the patient while awake is more conscious of this irritation than during sleep.

2. *Hæmaturia*, as a symptom of stone in the bladder, is traumatic in its origin. It arises from the direct mechanical injury done to the gorged vessels near the neck of the bladder by the stone, or, exceptionally, from the

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[1] See T. H. Bartlett's case. Lancet, Feb. 5, 1876, p. 210.

intensity of the cystitis alone. Hence it is valuable as an early diagnostic sign of stone, and is generally noticed after exercise. It is rarely absent in children, frequently lacking in old men. In doubtful cases it may be recognized by the smoky tint of the urine, or even the microscope may be required. Hæmaturia is so common that it has no value as a symptom, except when combined with others.

3. *Sudden stoppage of the stream during urination* is caused by the action of the stone as a ball-valve, the urine carrying it into the vesical orifice of the urethra. Children commonly present this symptom, while old men frequently escape for the reasons given above. Conversely, the symptom occurs sometimes in cases of pedunculated prostatic tumor, and in cases of irritability and spasm of the cut-off muscles of the deep urethra, the cause of the spasm being generally reflex, and due to some disturbance of the prostate, bladder, or kidneys, or possibly sometimes to a stricture of the pendulous urethra. Occasionally the obstacle to urination is so great that the patient has to assume some unusual position in order to urinate at all. Eve, of Nashville, lithotomized a patient who for two years before his operation had had to lie down when he wanted to urinate, and with a finger in the rectum push the stones in his bladder well up before the flow would start. One hundred and seventeen calculi were removed from this patient by the cutting operation.

4. *Pain* in the bladder and penis is common with stone, especially in children; old men may have little or none. When present, the pain is certainly aggravated by exercise. Encysted stones may cause but little pain.

5. The pain referred to the end of the penis is nearly as common in adults and old people with chronic cystitis without stone, as in those who have it. It is more intense with stone, and more often follows than precedes or attends urination. In young people, this pain, with *tendency to pull upon the penis*, is nearly pathognomonic of stone.

6. *Pus in the urine* is more often due to other causes than to stone.

7. *Vesical tenesmus*, very intense in children, and in adults and old men during an "attack of the stone," is far from being confined to patients with calculous disease. It exists in many conditions of cystitis, from whatever cause, while its absence in the old man with a small stone does not save him from the suspicion of having calculus, or excuse the surgeon for neglecting to search.

8. *Distant reflex pains* occur with stone, pains seemingly having no direct relation with the nerves supplying the bladder. Hunter's[1] well-known case of the father of Lord Cavendish is in point, where a pain in the left arm existed as a reflex symptom of stone in the bladder.

Pains in the back, loins, stomach, or thighs, may be due to vesical calculus and relieved by its extraction. Pododynia or podalgia, pain in the foot, is often a reflex symptom of irritation near the neck of the bladder or in the prostate, and may be associated with stone. It is very rare in young persons, quite common in old men, but more often absent than present in a case of stone at any age. It is a pain in the foot, usually the sole, generally occupying one of the phalanges or the ball of the great toe. This pain may be a sharp sensation, a feeling of burning, or one of intense coldness. When due to stone it disappears with the extraction of the stone, but it may exist as a symptom of vesical, prostatic, or urethral disease, or may be due to gout or to alcoholic excess when the bladder is quite sound. T. B. Curtis[2] has collected a number of interesting examples of this peculiar reflex pain, among them Pitha's own severe attack of cystalgia, which induced that distinguished urinary specialist to cause himself to be sounded for stone no less than five times with negative result. Curtis also quotes Pitha's account of Dr. Reisch, who, while suffering with stone, had a sensation as though his left foot[1] were placed upon a red-hot plate. The size of the hot spot diminished as the stone grew smaller at each sitting of lithotrity. Finally only a small point remained. Pitha believed that he had removed every fragment. Search found nothing, but the pododynia persisted and the patient declared that a small fragment of stone certainly remained. Further search discovered this fragment. It was removed, and the pain in the foot departed. Marshall Hall's[2] case of spasm of the sphincter ani is well known, and a very instructive case is referred to by Gross,[3] as observed by John Duncan, of Scotland—that of a five-year old boy with epilepsy of two years' duration, due to stone and ceasing permanently a fortnight after successful lithotomy.

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[1] Hunter's Works, Palmer's edition, vol. i. p. 321.

[2] Boston Med. and Surg. Journ., April 7, 1881, p. 316.

9. *Priapism.*—This, like nearly all other symptoms of stone, is more common in infants and young persons than in the adult or aged. It is not induced by or attended with sexual emotions in the adult, as a rule. A boy having the erection at first mechanically, may afterwards by association have sexual inclinations with his erections, and may become confirmed in a habit of masturbation. The erection is undoubtedly due to a turgescence of the vessels in the prostatic sinus and about the neck of the bladder, and is irritative in character.

Yet occasionally erotic desires may occur as a symptom of stone late in life. Such a case is recorded in a man of 85 by Bouvier.[4]

10. *Symptoms of Chronic Vesical Catarrh.*—The infant or young person does not very often have this symptom of stone in the bladder, while in an old man it may be absolutely the only evidence of the existence of stone.

DIAGNOSIS OF STONE.—The subjective symptoms of stone are only suggestive; no positive diagnosis can be made without the aid of physical means. The most common of these is sounding.

Many devices have been resorted to to improve this manœuvre, such as the use of a peculiar polish upon the metal sound, that it may show a scratch, or the addition of a sounding board to the searcher, or the attachment of a tube to connect the searcher with the surgeon's ear, or the adaptation of a microphone to intensify the sound.

These appliances are certainly not surgical. If the surgeon's hand is not delicate enough to detect the contact of his searcher with a stone without the aid of hearing, it will be wiser for him not to attempt to deal further with the surgery of the bladder. There is not generally any difficulty in hearing the sound of a stone as it is struck, if the bladder contains some fluid, so that the end of the searcher may be freely rotated and a little force be given to the stroke. This sound aids the touch and helps the surgeon to differentiate between a hard and soft stone; but the sound is very inferior to the sensation imparted to the fingers through the searcher when it touches calculous material.

The difficulty in finding stone is not to recognize it when it is touched, but to touch it at all, if the bladder is capacious; for it may elude all search when the bladder is full, and may be covered by the loose folds of the viscus and out of reach when the bladder is empty.

On one occasion, I was called to decide, in the case of an old man with a capacious, atonied bladder, whether stone was present or not. A prolonged search proved negative, and the decision stood against the probability of calculus. As the bladder had been injected with water, however, I asked the patient to stand up while I drew off the fluid through a soft catheter. This he did, and as the last drops were coming away I recognized the gritty feel of a small stone against the soft catheter, and verified the fact after the bladder was empty by pushing the catheter back and forth several times. Lithotrity promptly relieved the patient.

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[1] According to my observation, the left foot is generally the one to suffer.

[2] Diseases of the Nervous System, p. 339. London, 1841.

[3] Urinary Organs, 3d edition, p. 197. 1876.

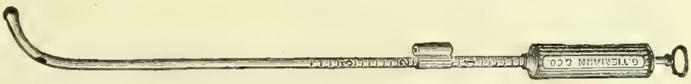
[4] Bull. de l'Acad. de Méd., t. ii. p. 815. Paris, 1837–8.

The Bigelow washing bottle and small tube would decide a case like this at once.

Only two instruments are essential to discover a movable stone in the bladder—a searcher, and a washing bottle and metallic tube. In many instances, no especial form of instrument is necessary, and anything thrust into the bladder—a catheter, hard or soft, a common steel sound, or a lithotrite—strikes against the foreign body and reveals its presence even to the unskilled touch. Sometimes such instruments fail. A lithotrite is too heavy for delicate handling if the stone is small. A soft instrument cannot be directed over the various surfaces of the bladder. An instrument with a long curve has so wide a sweep that it cannot be manipulated at all except in a bladder full of water, and even then it is a physical impossibility to bring its tip into contact with the *bas-fond*, just behind an enlarged prostate, the very seat of election for small stones in old men.

An instrument with a flat handle like that of the ordinary sound is not a good searcher, because it cannot be evenly and lightly rotated. A good searcher must be very light, composed of metal, and hollow, that urine may be withdrawn or water injected during the search without removing the instrument; it should have a slight bulb at its tip, and a cylindrical, corrugated handle, easy to grasp and to rotate. Probably the best instrument of this sort which has yet been devised, is Thompson's searcher.

Fig. 1199.



Thompson's searcher for vesical calculus.

This is usually made of white metal, graduated in inches, and furnished with a movable collar for roughly measuring the diameter of the stone. The common size for the adult is about 15 of the French scale, for the infant about 8.

To *sound for stone*, the patient is placed upon a table or firm couch, lying upon his back with the shoulders low, and the pelvis raised upon a hair cushion or other solid support so that it may be several inches higher than the shoulders. The thighs and legs are extended and lie flat. The bladder should, when possible, contain about three ounces of liquid. Special chairs and tables for sounding have been devised; upon them the patient is strapped and the pelvis raised or lowered at will. Like the microphone and sounding board, these devices are more impressive than useful. The surgeon may prefer to have the thighs and legs flexed so as to relax the abdominal walls. This is a matter of indifference except when it is desired to explore the roof of the bladder with the tip of the sound. In such case relaxed abdominal walls allow pressure over the bladder to bring all parts of the roof of the viscus within reach of the tip of the instrument. Most male adults can be searched as well without an anæsthetic as with it. With women and children anæsthesia is always appropriate, in the former for reasons of delicacy, in the latter to restrain spasmodic ejection of the urine, and to insure quiet manipulation, which is essential to all accurate searching.[1] In any case when pain is great, the bladder very irritable, or the patient nervous—and particularly for a second search after one negative exploration—it is wiser to use ether than to risk failure without it.

If the stone is movable and the bladder contains fluid, when the pelvis is raised higher than the shoulders, the stone will roll away from the tender neck of the bladder and rest at the fundus behind the trigone, where it is most easily found.

The surgeon, standing at the patient's right side, introduces the searcher gently, making its heel slide along the membranous urethra and the floor of the prostatic sinus, and aiding its passage through these segments of the urethra by pressing the skin over the pubes towards the feet, with the left hand, so as to relax the suspensory ligament of the penis. In some cases the whole search is made less painful by keeping the ligament so relaxed through the entire sitting. When the heel of the searcher enters the bladder it should be carried gently down the inclined plane formed by the base of the bladder until it is arrested. Most often the stone will be struck at this point. If not, then the toe of the searcher should be gently rotated as far as it will go, first toward one and then toward the other side of the bladder. Next, the searcher is drawn forward, well inclined toward one side, and by rotating the cylindrical handle, gentle taps are given to the wall of the bladder, along the entire side as far forward as the instrument can be drawn. It is then slid back to the fundus along the course it has just traversed. This double passage is repeated on the other side of the bladder. Next, the beak of the sound is reversed, and the whole floor of the bladder is swept by to-and-fro lateral motions of its tip, as it is brought forward to the vesical neck and carried back again to the fundus.

If the result is negative, some water may be drawn off and the search repeated, or, an expedient which I have found of great value, the patient may be asked to stand erect with the searcher still in his bladder, and the urine may be drawn off through the searcher while he is standing, leaning forward upon a chair for support. As the urine flows away, the beak of the sound should be held quite near the neck of the bladder, and rotated from side to side until every drop of urine has passed. It is difficult for even a minute stone to escape detection by this method.

Should a stone be touched, the bulbous tip of the searcher passed over its surface will indicate whether it is rough or smooth. The character of the click produced by tapping the stone gives a clue to its composition, a dull, low-pitched sound indicating a soft phosphatic stone, while a clear, high-pitched click indicates uric acid or oxalate of lime.

If, when the patient is quiet, the sound strikes a stone in being rotated first to one side and then to the other, it is probable that two stones are present. Better evidence as to the composition of the stone is furnished by the condition of the urine and the crystals it contains, than by the nature of the click. Thus, if crystals of oxalate of lime, uric acid, cystine, or triple phosphates abound in the urine, it is fair to presume that at least the last coatings of the stone are composed of similar crystals.

Another point in the diagnosis of stone is its size. This may be approximately ascertained as follows: The searcher is pushed to the back wall of the bladder, and then gently brought forward, tapping the vesical wall on the side upon which the stone lies until the latter is touched. Now the sliding collar on the shaft of the instrument is pushed down to the meatus, and the tappings on the surface of the stone are continued as the searcher is withdrawn, until a certain tap clears the stone and strikes the bladder in front of it. The graduations on the shaft of the searcher, between the sliding collar and the meatus, mark approximatively one diameter of the stone. The actual diameter is best ascertained with a small lithotrite, and multiple stones are best demonstrated by seizing one of them quite firmly in the jaws of the lithotrite, and using this as a searcher to strike one or more stones on either side.

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[1] The injection of a four-per-cent. solution of the hydrochlorate of cocaine in some cases makes the use of ether unnecessary.

The size of a stone may often be estimated by passing one or two fingers into the rectum and feeling the stone between the finger and the searcher, or, in a thin person with a large stone and small prostate, by bi-manual palpation, one or two fingers in the rectum, while the other hand pushes down the abdominal wall over the bladder. With large prostate and deep *bas-fond*, a finger in the rectum will sometimes elevate a small stone within the reach of the searcher.

A stone may still escape detection by being encysted or situated in a hernial pouch, or behind an hour-glass contraction, or wrapped up in a blood-clot, or in a mass of mucus so as to yield no sound or sensation of hardness to the searcher.

In cases of grave doubt, the bladder may be examined with straight and long curved sounds as well as with the searcher, and by lifting the floor and depressing the roof of the bladder so as to bring the point of an instrument into contact with every part of its wall. The lithotrite also would be of service in finding a stone enveloped in blood or mucus, as would extreme distention of the bladder with warm water, and a change of position to throw a stone out of a large pouch or double bladder, if there should be any reason to believe this condition to exist. Furneaux Jordan,[1] in one case of tight stricture, sounded with an acupuncture needle through the perineum, and struck a stone.

But all these means occasionally fail when a stone is very small. In such case no searcher approaches the accuracy of the washing bottle and small metallic evacuating tube, straight or curved—the Bigelow apparatus for washing in litholapaxy. Such a tube being introduced, and the apparatus so managed that not a particle of air enters the bladder, the swash of the water will certainly bring any small stone into contact with the tube, and the sharp click can be plainly felt by the surgeon or heard by any one placing his ear over the bladder. This means in my hands has proved successful in more than one instance when all other efforts had failed.

Notwithstanding the accurate means of investigation now possessed by the surgeon, it is still possible occasionally to overlook a stone, and in a doubtful case at least two examinations ought to be insisted upon before giving a final opinion; and the second of these examinations should be practised with the patient under the influence of ether, and should be made with the searcher, washing bottle and tube, and lithotrite. Even then an error may be made: a small tumor, encrusted with crystals, may be declared to be a stone; or a calculus may be overlooked, lying in a cyst, sacculus, or pouched ureter, or shrouded in a blood-clot or mass of viscid mucus.

The fact, moreover, is of record that the very best surgeons (Cheselden, Morgagni, Abernethy, Dupuytren, Chopart) have failed to find large stones in the bladder, which an autopsy has revealed, while others, equally distinguished, have cut for stone and found none. To say nothing of a host of minor operators, the great Cheselden cut three times for stone and found nothing. Dupuytren, Roux, and Crosse, too, committed like errors.

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[1] Surgical Enquiries, 2d ed., p. 284. London.

Chronic thickening of the bladder, with or without tumor, ulcer, or heterologous deposit; feces in the rectum; pelvic exostosis; a displaced uterus; the hard pelvic brim, with a thin bladder-wall lying against it; a prominent sacral angle, and many other physical irregularities, have been mistaken for stone.

In one case with which I am familiar, a small stone was felt in a child. The lateral operation was performed. The bladder was distended, and a gush of urine followed the withdrawal of the knife. A search for stone was now instituted without result, when finally it occurred to the operator to examine the clotted blood in the vessel containing the urine, and there a small stone was found, evidently having been expelled by the first gush of urine.

Nourse is quoted by Gross[1] as reporting a case wherein nine calculi were lodged in six sacculi; and, although stone was once touched by the searcher, numerous subsequent examinations failed to detect it. He refers also to Pott's case of calculus in a hernial pouch of the bladder situated in the groin, and to Hartmann's, where a stone weighing three ounces was found in a hernial pouch of the bladder situated in one of the labia of a woman.

When very large stones have escaped detection, it is supposed either that the sound entered between the stone and the wall of the bladder, and was there so tightly held that it could not be rotated to strike the stone (but why the gritting sensation was not experienced, it is hard to understand)—or that the searcher failed to enter the bladder at all, being rotated in some dilated portion of the urethra mistaken for the bladder, as in two cases noted by Pelletan.[2] A pouched prostatic sinus may also be mistaken for the bladder in an old man, and thus a stone be overlooked. I have encountered an instance of this sort, and others are on record in which, the prostate being destroyed by suppuration (Muller, Civiale), the patient has been cut into this cavity and not into the bladder, and no stone has been detected until subsequently revealed by an autopsy.

Hence it would seem that the masters of surgery in former days had good reason in formulating the cardinal rule in lithotomy, that even after the presence of a calculus had been recognized, and the patient was placed upon the table, if the stone could not be struck then and there, it was better to defer the operation. It is difficult to imagine sometimes what it has been which has deceived the skilled touch, but grave errors have arisen, and their lesson must not be disregarded. In many cases where a doubt suggests itself that there may be no stone, although something is struck by the searcher which resembles stone, a small lithotrite, by grasping the foreign body and moving it, will clear up all uncertainty.

Finally, it must be remembered that sounding a patient for the first time is an operation not devoid of risk. Fatal cystitis has been occasioned by it in more than one instance (Prout, Fletcher, Civiale, Crosse, and others). No unnecessarily prolonged, rough, or repeated manipulations should be practised at a first sitting, or indeed at any time.

THE PREVENTIVE TREATMENT OF STONE.

Prevention, as a treatment for expected stone, is generally first thought of after a patient has passed a renal concretion. But the question may arise earlier than this, in connection with a possible inherited tendency to calculous disease, or in directing a course of life for a patient who persistently voids large quantities of crystals. Of the two great classes of stone, one, the primary, is of constitutional or diathetic origin, and requires general measures to counteract the tendency to its production; the other, secondary, is of local origin, and local preventive measures are here vastly more important. The latter are almost too obvious to require mention. They involve all the physical means employed for the relief of obstructive urethral and prostatic disease—removal of nuclei, the use of the catheter, vesical irrigation, medicated injections, and other means for controlling vesical catarrh—for without catarrh it is impossible for secondary stone to form. In the kidney and ureter it is often impossible to apply local measures, and here it is, therefore, that secondary stone once originated most often goes on, uninfluenced by any measure brought to bear against it. A somewhat brighter future for these conditions is promised by nephrotomy.

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[1] Op. cit., pp. 205–207.

[2] Ségalas, Essai sur la Gravelle et la Pierre, 2me éd., p. 155. 1839.

There are certain general measures, however, which seem to oppose secondary stone formation even in the kidneys; these are the use of—

(1) A milk diet, when well borne by the stomach;
(2) An abundance of bland, diluent drinks;
(3) Tonics;
(4) Mineral acids (sometimes);
(5) Alkalies (sometimes);
(6) Benzoic acid—occasionally—or the salicylates.

(1) A milk diet, if well borne, sometimes reduces catarrhal inflammation of the urinary mucous passages to a remarkable extent. Should a nucleus be present, however, no amount of milk diet can cure, although it may moderate, a local catarrh of that portion of the membrane upon which the foreign body lies.

(2) Diluents act by lessening the irritation of the mucous surface through the greater blandness of the fluid which bathes it. In this way most of the mineral waters act which seem to have power in reducing chronic catarrhal urinary conditions. Such waters as the Bethesda, Poland, Clysmic, Glen Summit, Mountain Valley (Arkansas), certainly do not act by virtue of any mineral ingredients, and are not, as a rule, much more valuable than filtered rain water taken very freely. They wash out the urinary passages and reduce irritation, but they do not dissolve stone, either alkaline or acid. The waters of Wildungen and Contrexville probably act in a similar manner, although an especial claim is made for the latter that it dissolves mucus and tends to cause a diminution in the excretion of phosphates. I have no personal knowledge of the truth of these claims.

(3) Tonics act by improving the digestion and the vitality of the tissues, and (4) mineral acids act in the same way, and not directly through the urine. In a catarrhal condition of the urinary organs the administration of acid generally does not render the ammoniacal urine acid, but, by making the urine more dense, it may increase the grade of the catarrh, and consequently intensify the alkalinity of the urine.

(5) Alkalies, on the other hand, sometimes agree very well, and by diminishing the acidity and acridity of the urine at the kidney, lessen the grade of the catarrh, and sometimes even gradually restore normal acidity to the urine.

(6) Benzoic acid in 10-grain or even larger doses, in capsules, will sometimes arrest ammoniacal changes and allay catarrh, but it is a substance not well borne by most stomachs. Salicine, salicylic acid, the salicylates, and even oil of wintergreen, chlorate of potassium, and naphthaline, have been found serviceable in some cases. Sometimes useful, they are generally powerless to do good, but where they do act their influence is antagonistic to secondary phosphatic stone formation.

Concerning the formation of *primary acid stone* something more may be said. It is difficult to speak definitely of this class of cases, with the exception of those included in the uric-acid group. A primary acid nucleus is most often composed of uric acid and the urates, and inherited tendencies to stone usually manifest themselves by precipitation of the same salts.

Here it is, fortunately, that preventive measures are of most avail; indeed, in this direction only has any serious advance been made.

A tendency to lithiasis being recognized by the constant or intermittent occurrence of urates and uric acid in the urine, and especially after one kidney stone has been voided, the problem which arises is, How shall another nucleus be prevented from forming? The answer may be best given under six heads:—

(1) Regulation of diet.
(2) Attention to exercise.
(3) Promotion of elimination by other channels.
(4) Dilution of the urine.
(5) The use of solvents.
(6) Attempts to avoid crystallization in colloidal forms.

(1) Thompson has given this subject more study than any other surgeon, and with a greater measure of success. Uric-acid causation unquestionably lies behind the kidney, in the state of the blood furnished to that organ; and the blood again derives its qualities to a considerable extent from the quantity and quality of the food, the state of the digestion, and the effect of air and exercise upon the blood. Physiology would naturally suggest that when the urates are in excess, the diet should be limited in its nitrogenous elements. In practice, however, as Thompson has taught and experience daily proves, the very opposite is the case, and it is the alcoholic, saccharine, and fatty elements of food, and not the meats, which have to be cut off when we propose to reduce habitual tendencies to uric-acid formation.

The reason for this seems to be that these elements tend to make the liver "torpid," as it is called, and in some way to interfere with the proper elaboration of the blood.

In practice, manifest advantage arises from giving up alcohol, especially all sweet fermented and malt liquors, and the stronger wines, Madeira, port, and sherry. Beer, champagne, and liqueurs are very harmful, unless an exception be made for very dry champagne. If some alcoholic stimulant must be taken for the stomach's sake, or on account of advanced age, or for other reason, a choice should be made among the sound, light, red wines of France—the Bordeaux wines—and the thin Rhine wines; or, if more alcohol be required, a little very old brandy, whiskey, or gin, well diluted in water, may be used.

Sugar in any form is harmful, and should be discarded as far as possible from the dietary. Of the different kinds of fat, the same remark holds good, but to a less degree. Fried fats, rich gravy, and pastry are to be condemned; even milk and pure butter are sometimes harmful, but not always so. These latter substances do not alter in any degree the solid constituents of the urine, if we may place confidence in the results of the experiments of Dr. Böcker, as quoted by Garrod,[1] which show that "no influence whatever is exerted on the excretion of water, urea, uric acid, or any other constituent of the urine, by taking from about a quarter of an ounce to three ounces of butter daily."

A proper diet is one composed of meat, especially poultry and fish, bread, all the cereals, green vegetables, salads, and fruits, with sometimes milk, butter, and eggs, if the latter substances agree with the patient's digestion.

Certain kinds of food appear to possess special value. The experiments made conjointly by Heller and a friend, also referred to by Garrod,[1] are suggestive. Heller first found out how much uric acid he and his friend excreted daily under a stated diet. Then Heller lived for a week on rye and wheaten bread, his friend on rye bread alone, water being their only drink. The uric acid was gradually replaced by hippuric acid, and finally only a trace of it remained in Heller's urine, none at all in the urine of his friend. During the next week, having returned to ordinary diet, the hippuric acid diminished and the uric acid reappeared.

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[1] Uric Acid, its Physiology and its Relations to Renal Calculi and Gravel. Lancet, April 21, 1883, pp. 670–673.

(2) Exercise in the open air is a prime factor in the reduction of uric-acid deposits. Any one subject to these deposits can bear testimony to the value of a summer in the woods, or of horse-back exercise persistently practised.

(3) The elimination of uric acid and its compounds by other channels than the kidney, is an important element in the preventive treatment of primary stone. It is on a par with the treatment of gout as carried out at Carlsbad, and indeed the dietary regulations are founded on the same basis. The plan is to act upon the liver and intestinal glands by one of the natural mineral waters containing sulphate of sodium and sulphate of magnesium in solution. Thompson has proved that a dose of one of these waters will be amply cathartic, although the actual amount of sulphate of magnesium and sulphate of sodium in the draught be only one-fourth the amount required, if the same drugs are bought of the apothecary.

The waters which are most suitable are the Hunyadi Janos and the Friedrichshall. The former is nearly three times as rich in the requisite ingredients as the latter, and may be used in a correspondingly smaller dose. Both should be taken warm, fasting in the morning, and in some instances the effect is enhanced by diluting the draught, the Friedrichshall one-third, and the Hunyadi more than one-half, with hot water. The daily dose should be sufficient to cause one free and rather watery stool after breakfast, or even two at the beginning of a course. A small claret glass of Hunyadi, or a moderate tumblerful of Friederichshall, is the customary dose to begin with, but this may be reduced in most instances as the course goes on.

At the beginning of such a course, and occasionally during its continuance, a blue pill may be administered with advantage, or a compound rhubarb pill (5 grains) with the addition of $\frac{1}{8}$–$\frac{1}{12}$ grain of blue pill (Thompson).

Such a course should continue about two months, the mineral water being gradually reduced in amount each morning, and replaced by hot Carlsbad water, at a dose of about one tumblerful. The course may often be repeated with advantage after an interval of three or four months, and many patients will continue a light morning dose for years, with apparent advantage and no depleting effect.

Where the patient is poor and cannot afford mineral waters, an efficient morning dose of Glauber's salt, with a slight addition of sulphate of magnesium, may be substituted. This course freshens the patient, diminishes dyspepsia, and increases the sense of comfort and well-being, while it unmistakably reduces the amount of urates and uric acid in the urine.

Another method of reducing the amount of uric acid is now undergoing investigation. Garrod has observed that the urine of a sucking calf contains uric acid, but that when the calf gets older and lives on grass, the uric acid disappears and hippuric acid takes its place. Garrod also found that if the urine of a herbivorous animal was added to human urine and allowed to stand, no uric acid could be detected in the specimen, and that a solution of uric-acid calculus mixed with carbonate of lithium and added to the urine of a horse, failed to yield, when kept a few hours, any uric acid.

The inference was plain, that the renal epithelia of the herbivora were capable of excreting uric acid, but that the hippuric acid in solution subsequently destroyed it.

Garrod also investigated the conversion of benzoic acid into hippuric acid in the animal economy, and is now experimenting with hippurates and benzoates of sodium and potassium with results that he at present only indicates as having given him "great advantage" in the treatment of gout, of gravel, and of calculus.[1]

(4) Simple dilution of the urine is another useful means of counteracting tendencies to acid stone formation. If properly carried out, no harm comes of it, and at least negatively it has value, for the greater the quantity of water with a given amount of solids to be eliminated, the less will be the tendency to precipitation. Many individuals with concentrated acid urine have very little thirst, and are habitually light drinkers of water. A habit of drinking water freely may be encouraged. During meal times it is better to drink hot than cold water. The digestion is aided by such draughts. Between meals at any time a glass of water may be taken, and if it is not too near a meal, iced water is as harmless as anything else. On retiring, also, a glass of water is particularly useful, since it serves to dilute the urine secreted during the night, which is more concentrated than that secreted at any other time. Filtered rain water is excellent for these purposes of dilution, or any of the simple diluent spring waters—the Bethesda, Poland, Mountain Valley, etc.

(5) The use of solvents is a very prompt method by which urates and uric acid may be made to disappear, but it has less real value than those already mentioned for continuous use. By administering the citrate or the acetate of potassium, or the bicarbonate of sodium or potassium, or by the use of Vichy, Buffalo Lithia, or other natural alkaline mineral waters, the urates and crystals may usually be made to disappear from the urine, and the uric acid storms, as they have been called, may be calmed.

These agents are of undoubted value, and in many conditions approaching an emergency can hardly be dispensed with. Their promptly effective action so long as the stomach is tolerant, is a valuable aid to the surgeon. For prolonged use, and when the patient's tendencies toward acid formation are very strong, the alkaline solvent treatment is not always available, since it may induce dyspepsia and lead to anæmia. When alkalies are used, they should be exhibited during the third hour after eating, at the time when the acid in the chyme is neutralized, or has been reabsorbed. Then the alkali is promptly absorbed and exerts its maximum effect upon the urine.[2]

In my experience, if a course of alkalies is suitable and necessary for a very long period in the preventive treatment of stone, the boro-citrate of magnesium is a good preparation. This nearly tasteless powder may be taken dry upon the tongue in a dose of ten or more grains, and washed down with a swallow of water. It seems to tax the stomach less than the citrate of potassium, and some patients assert that it is of service. Like other alkalies, it should be given during the third hour after eating.

The formation of oxalate-of-lime crystals, as is well known, may be modified by the use of dilute nitro-muriatic acid, and the aid of this drug may be invoked in acute outbursts of uric-acid or oxalate-of-lime crystallization when digestion is at fault. To prevent cystine formation, Beale[3] uses carbonate of ammonium freely.

(6) An attempt to avoid crystallization in colloidal forms, is, perhaps, the most scientific direction that the preventive treatment of stone can take, but it is at the same time the most vague. The main colloid for acid stone is

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[1] Loc. cit., p. 673.

[2] Ralfe, Observations on Urinary Pathology and Therapeutics. Lancet, Nov. 9, 1879.

[3] Lancet, August 30, 1884, p. 263.

probably mucus, and a little scratching of the mucous membrane by the sharp points of crystals, or irritation by concentrated urine, is sufficient to call out enough mucus to act as a colloid and determine the character of the crystals. Hence all efforts to make the urine bland and abundant are justified on purely scientific grounds. But the question is, Does any substance exist which militates directly against stone formation, either by reducing the colloids or preventing their action? To this no answer can be given, but a substance has of late been brought before the notice of the profession, which perhaps acts in this way. I refer to the fluid extract of hydrangea which has been mentioned during the past few years a number of times in the American medical weeklies, as an agent calculated to arrest paroxysms of renal colic, and even to relieve them when present. My experience with this drug is limited, but I think that I have seen some slight advantage follow its use in half-drachm or drachm doses after meals. Cider also, as an habitual drink, has given good results in my experience. The cider need not be absolutely sweet; ordinary bottled cider answers all purposes, or even cider which is slightly hard.

Electrolytic Treatment of Stone.

That the electric current influences crystallization has long been known. Ord states that magnetic currents cause oxalate of lime crystals to reach an unusually large size, and refers to Bridgman as asserting that submorphous forms of crystals (colloidal) appear sooner under a mild galvanic current than they would otherwise do in the same liquid. The construction of stone may thus be aided by electricity, and disintegration of calculi has been effected by the same agency.

Bouvier-Demortiers first thought of dissolving stones with the voltaic pile, and Gruithuisen, in 1813, found experimentally in the laboratory that with platinum points and a number of elements stones might be pierced by this means. In 1823, Dumas and Prévost[1] found that a fusible calculus of 92 grains, under the action of a pile of 120 couples, recharged hourly, lost 12 grains in 12 hours, and after 28 hours became a friable mass which crumbled on the slightest pressure. They experimented on a dog, and found that the process could be conducted without injuring the bladder. They then experimented in the human bladder, but, with negative results, since uric-acid calculi, being formed of one substance, were not suitable for voltaic dissolution. Dumas and Prévost injected into the bladder a solution of nitrate of potassium, hoping to make by electrolytic action a soluble urate of potassium, but the experiment proved negative.

Leroy d'Étiolles followed up these attempts, but came to negative conclusions. Bence Jones did the same, in England, in 1852. Erckmann,[2] under the auspices of Dr. Raymond, announces some successful experiments. Leroy d'Étiolles (fils),[3] who saw the patients of Erckmann, does not consider the facts conclusive or the cases established, and to-day electrical lithomalaxy has no recognized place among the legitimate operations for stone.

Solvent Treatment of Stone.

Pliny[4] speaks of the ashes of snail-shells as a proper solvent for stone. Hippocrates and Galen do not appear to have had confidence in any substance, but since Pliny many investigators have given time and attention to a study of the medical treatment of stone. The laity almost uniformly believe that stone may be dissolved by medicine, and tons of pills and powders, rivers of supposed solvents, and oceans of mineral waters have been consumed by the victims either of stone or of their imaginations, in the delusive hope of cure. Aretæus, in the second century, introduced quicklime as a stone-solvent, and Paulus Ægineta, in the seventh century, mentions that some persons thought well of goat's blood. Avicenna (tenth century) was quite convinced of the efficacy of the impure carbonate of potassium, but his prescriptions were nauseating compounds containing a number of absurd ingredients in addition to the usual alkali, and his methods did not retain favor with the profession.

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[1] Annales de Chimie et de Physique, Juin et Juillet, 1823.

[2] La lithomalakie électrique. Paris, 1863.

[3] Op. cit., p. 540.

[4] Hist. Nat., lib. xxx. cap. viii.

Later authors, from Basilius in the fifteenth century to Mrs. Joanna Stephens in the eighteenth, used the same alkalies—potassa, lime, and soda—in simple combinations with vegetable diuretics, given by the mouth or injected into the bladder. Many contented themselves with such remedies as the infusions and decoctions of various plants, roots, bulbs, or fruits, carbonic acid in water, distilled water, goat's blood, etc. The names of Blackrie, Chittick, Darci, Morand, and Girardi become familiar in looking over the literature of this subject.

In France the first sign of intelligent direction of the solvent treatment appeared when Fourcroy and Vauquelin did what they believed to be wise in using dilute acids in the treatment of alkaline stones, and alkalies in that of acid concretions.

No remedy reputed to be a stone solvent has had such renown as that of Joanna Stephens. Physicians and patients in England became generally convinced of its value, and the English Parliament, after a long inquiry, under full conviction of its worth finally, in 1739, bought the secret of Mrs. Stephens at the modest figure of £5000.

The medicines so purchased proved to be a powder of calcined egg-shells and snails; a decoction of herbs with soap, ashes of swine's cresses, and honey; and a pill of calcined snails, wild-carrot seeds, burdock seeds, ashen keys, hips and haws—all burnt to blackness—soap, and honey.[1] These compounds apparently effected wonders as long as they were secret remedies, but, their composition once disclosed, they soon lost their charm and fell into disuse.

So celebrated did these remedies become that Morand was appointed by the French Academy to go to London to look into the merits of the Cheselden cutting operation, and the cures by the Stephens remedies. On his return he reported[2] that the remedy had been tried upon forty patients, in twenty-two of whom stone had been touched with a sound. Five of the latter were finally cut, and their stones showed no evidence of erosion. Morand found that some patients were soothed, and that some passed small calculi, worm-eaten in appearance, after taking the remedies; therefore he thought favorably of the medicines, although none of the patients reported as cured would allow themselves to be sounded again.

But the most pungent criticism upon the remedies of Mrs. Stephens, is that each of the four patients whose cures were vouched for by the trustees appointed by the Government, and who had refused to allow themselves to be sounded, died with stone in the bladder, as proved by post-mortem examination in each case.[3]

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[1] Gentleman's Magazine, June, 1739, vol. ix. p. 291.

[2] Mém. de l'Académie des Sciences, Années 1740-41.

[3] Alston's Lectures on the Materia Medica, vol. i. p. 268. London, 1773.

This experience was repeated in other alleged instances of cure, as may be seen by looking into the rather extensive literature of the period.[1] Many patients, on the other hand, who took these remedies, had no stone at all, but being relieved by the alkali of certain symptoms, testified that they had been cured of stone.

As soon as it began to be supposed that the lime in burnt egg and snail-shells effected the cure, Whytt, of Edinburgh, devised a cure by lime-water and soap, and published, among many others, the case of one David Miller, who took three pints of lime-water and an ounce and a half of Castile soap daily, and passed some broken fragments of stone, and in whose bladder, when he died eleven years subsequently, no stone was found.

Mascagni, in Italy, published his own case as an example of cure by drinking Seltzer water and a weak solution of bicarbonate of potassium. He had lumbar pains, and passed some acid gravel during the treatment.

Heller[2] reports the cure of a case of urostealith calculus, by administering two drachms of carbonate of sodium daily. The patient voided considerable masses of urostealith, and was pronounced cured in a fortnight.

Chevalier and C. Petit, in France, stand at the head of the investigators into the value of natural mineral waters, notably Vichy, in dissolving stone; but some of their conclusions have not been confirmed, as, for instance, that triple-phosphate calculi are acted upon more efficiently by Vichy water than stones of uric acid (Petit); and Petit again made a famous mistake[3] in asserting the cure of stone in a well-known gentleman, from whose bladder a stone as large as a hen's egg was removed after death.

The committee appointed by the Academy of Medicine to examine the claims of Petit, decided against the probability that urinary concretions, "large enough to constitute actual stones," could be cured by the waters of Vichy; yet even to this day patients with stone and gravel go to Vichy under the belief that their stones can be dissolved.

The most serious scientific effort which has been made to establish the solvent treatment of stone, is that of Roberts,[4] of Manchester. Basing his conclusions upon a large number of careful experiments, performed upon stones with various alkaline solutions out of the body, Roberts finds the carbonate of potassium to be the best solvent for uric-acid concretions; much better, he thinks, than the salts of lithium or sodium. If the solution be too strong, an alkaline bi-urate coats the stone, and further solution ceases, but such excess of alkalinity can hardly be maintained in the body. The citrates, acetates, and other alkaline salts given by the mouth, are all eliminated as carbonates in the urine, and the salt which in practice Roberts finds most effective, and least likely, by long-continued use, to upset the stomach, is the citrate of potassium.

But the citrate of potassium may prove to be too diuretic, making the alkaline solution of urine too feeble to be effective. In such case he substitutes for it, in part or wholly, the bicarbonate of potassium or sodium, or the liquor potassæ. The proper dose of the citrate, for an adult, is from forty to fifty grains in a gill of water every three or four hours, so that the daily dose shall be six drachms. The urine may become cloudy from precipitated phosphates, but this does not hinder solution, which continues unless the urine becomes ammoniacal, when all action ceases. Hence an essential condition is that the urine shall be normally acid at the start, and shall not become ammoniacal during the course of treatment. Roberts has continued these high daily doses of the citrate for many months without producing anæmia or gastric derangement.

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[1] James Parsons reports twelve such cases. (A description, etc., London, 1742.) Horace Walpole's case is in point. Thompson quotes it, and Le Roy d'Étiolles (fils) alludes to several very interesting cases.

[2] Heller's Archiv, Bd. ii. S. 2. 1845.

[3] Leroy d'Étiolles (fils), Traité pratique de la gravelle, p. 531. Paris, 1869.

[4] Urinary and Renal Diseases, Second American Edition, pp. 298–321. 1872.

On account of the vigorous presentation of his method by Roberts, no opposition has been made to his conclusions, as a rule, and his faith in the citrate of potassium has caused it to be generally accepted by the profession; but quite recently Garrod[1] has repeated the experiments of Roberts, and claims that the latter was wrong in his conclusions as to the relative efficacy of the potassium and lithium salts. He shows, indeed, that "the results were, in each case, more than fifty per cent. in favor of the carbonate of lithium." Garrod explains Roberts's error on the ground of his having used an impure lithium salt, or having employed only very weak solutions. The irritating action of lithium salts upon the stomach is also denied by Garrod, who appears to use the carbonate, but is not specific in his directions. He says:—

> The only effect I have ever noticed has been that, when the quantity has been increased beyond a certain amount, a little tremor of the hands is produced, which passes off at once on the diminution or omission of the dose of the salt. I have known patients of their own accord continue the use of lithium salts for more than ten years, with the effect of entirely preventing the recurrence of the symptoms to remove which they had first been prescribed, and without the production of any injurious effects. For myself, I have not the least doubt as to the value of lithium salts as therapeutic agents, and am convinced that, by their employment, depositions of uric acid in the renal organs can, to a large extent, be prevented. Free dilution and administration upon a fasting stomach are points of much importance, which should be attended to in the administration of alkaline remedies. I have been much in the habit of using potassium with lithium in the form of the citrate or the carbonate; the former to give neutralizing, the latter to increase the solvent power.

This certainly sounds promising, coming from such a source. The citrate of lithium is more soluble and more easily borne by the stomach than the carbonate. It may be given in from ten to thirty grain doses.

Injections of various substances into the bladder for the purpose of dissolving stone have been used successfully; Coulson alludes to a case in the practice of a Mr. Rutherford, but all these efforts have failed to favorably impress either the profession or the public, and Roberts demonstrates that the solution of acid stone by injection of alkalies is impracticable. Almond-oil and lemon-juice were injected by Baronius, the former as a calming agent, the latter as a solvent. Whytt used lime-water, as did also Butler, Campbell, and Rutherford. Hales tried, in animals, continuous irrigation through a double current catheter. Gruithuisen made some experiments in 1813, and Cloquet followed in 1821. He preferred distilled water as the substance to be injected. Attempts have been made to surround the stone in a rubber bag, and then to throw acid into the bag. Leroy d'Étiolles[2] made such attempts, and condemned not only them but all similar methods of treatment, and, following up the subject afterwards (1839–41),[3] decides absolutely against the practical utility of all forms of solvent treatment, whether used by the mouth or directly by injection. Hoskins's[4] nitro-saccharate and acetate-of-lead injections are of later date, their object being to disintegrate the calculus by double decomposition; but this method lacks the confirmation of practical success, as does also the use of acetate of lead (one grain to a fluidounce of water, with a few drops of acetic acid).

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[1] Lancet, April 21, 1883, p. 669.

[2] Exposé des divers procédés pour guérir de la pierre. Paris, 1825.

[3] Lettres à l'Académie de Médecine sur la dissolution des calculs.

[4] Coulson, p. 593, quoting from London Journal of Medicine, Oct. 1851.

Some reserve, perhaps, must be made in favor of the injection of dilute acids to dissolve phosphates precipitated in the muco-pus in catarrhal conditions of the bladder, and as a prophylactic against the tendency to phosphatic re-accumulation. Indeed, Brodie is quoted as having used a solution of two and a half minims of strong nitric acid to the fluidounce of water, injected through a double catheter for fifteen to thirty minutes two or three times a week, and as having succeeded in thus dissolving a phosphatic calculus.

In face of historic evidence, however, there can be but one deduction regarding the practical value of the solvent treatment of stone, namely, that it has no general applicability; and yet in spite of all evidence, and of all history, the virtues of various pills and waters are proclaimed to day by the proprietors of these nostrums, and by some of their dupes, as boldly as if Mrs. Stephens and her calcined shells had never existed, and the advertisements of mineral springs abound in seemingly well-attested instances of cure of stone.

A large stone cannot be dissolved, if for no other reason, on account of its animal matrix. For even allowing that the penetrating influence of the solvent could decalcify the outer layers to a considerable depth, yet the tenacious organic skeleton would remain adherent, arrest further solvent action, and form the best possible bed of colloid for new stone formation.

No pretence is now made in any scientific quarter that any stones can be dissolved by internal treatment, except those composed solely of uric acid, urates, or urostealith.

Beale's[1] recent announcement of the good effect of large doses of carbonate of ammonium in causing cystine to disappear from the urine, and the recurring passage of small cystine calculi to cease, must be borne in mind, and may make it possible to add cystine calculi to the list of those which we may hope to dissolve by the internal use of medicine. One of Beale's patients took 50 grains of ammonium carbonate three times a day, in a little water, for nearly three years.

Oxalate of lime and the phosphates, not uncommon substances to form layers in alternating calculi, are an absolute bar to solvent action. Ammoniacal urine is so likewise; and indeed so many conditions militate against the solvent method, that it is only the fascination lent to it by the possibility of success which has induced so many honest and competent observers to approach it. Yet being a possibility, it is a legitimate resource in those cases in which more radical measures are contraindicated, notably in dealing with small stones in the kidney. The best method is undoubtedly the one proposed by Roberts, possibly substituting citrate of lithium for the citrate of potassium, as suggested by Garrod. Success can only be hoped for after a very long course, and when the stone is quite small and the urine normal, or at least not ammoniacal. The deposit of sediment (phosphates) from the urine which may take place during the course is no indication that the stone is being dissolved, for it is an amorphous phosphate due to alkalinity of the urine, and not a dissolved urate, and the stone may still be actually growing in size.[2] Nor must it be forgotten that there is a possible element of error inherent in all methods of treatment by internal medication, or by the free use of mineral water, namely, the occurrence of a very positive and prolonged change in the specific gravity and reaction of the urine in which the stone lies bathed, a circumstance which would favor spontaneous fracture and disintegration, and might lead to spontaneous evacuation of the débris. This method of cure certainly sometimes occurs at mineral springs.

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[1] Lancet, Aug. 30, 1884, p. 363.

[2] Thompson, Clinical Lectures on Diseases of Urinary Organs, 6th ed., p. 129. 1882.

It is not worth while to attack a stone in the bladder, however small, by the solvent method, whether through the mouth or by injection, for the former plan is far too uncertain, and the latter requires vastly more instrumentation, even if it could succeed at all, than the single sitting of lithotrity by which the foreign body can be removed. Acid injections are a valid and valuable means of local medication against tendencies to recurrent phosphatic accumulations. The internal measures in vogue possess a symptomatic value apart from their alleged worth, in that the effect of the alkali is often soothing, and they may be used in any case to comfort the patient, though he should not be deceived into hoping too much from them.

Palliative Treatment of Stone.

In some cases radical treatment is not justifiable. Such are cases of large kidney-stones and phosphatic renal concretions where nephrotomy is not practicable, and all cases of vesical calculus in which, from the size or other peculiarity of the stone, or from the age, disease, or other condition of the patient, operation is contraindicated. In these cases, whether the stone is renal or vesical, the general outline of palliative treatment is the same. Milk diet is often a valuable adjuvant to treatment, as is sometimes a decided course of alkalies, as proved by the many patients who believe themselves bettered by taking the various advertised nostrums. The same remark applies to the use of the natural mineral waters. Both these remedies sometimes fail on account of their diuretic quality, for the mechanical effect of too frequent urination, when there is a foreign body in the bladder, is irritating.

The conduct of a case of this sort involves a judicious selection of anodynes and alkalies, rest, tonics, diet, and symptomatic local treatment. Much comfort may often be afforded when cure is impossible.

Selection of a Method of Radical Treatment.

Certain general conclusions have been established by statistics, namely, that the female tolerates lithotomy better than the male; the child better than the adult; the patient with diseased kidneys less well than any other. It has been proved, also, that the size of the stone influences the rate of mortality, and that an operation which may be best for one size of stone is less suitable for another. But statistics cannot demonstrate that one operation is better than another, simply because a given operator obtains brilliant results by a given method. There is no place in the literature of the present day for the heated discussions which flourished in France toward the middle of the present century as to the relative merits of lithotomy and lithotrity, as a general operation for all cases. The present discussion is narrowed down to more exact limits, and deals with special indications furnished on the one hand by the patient, on the other hand by the calculus, for the use of one or the other operation in any of the various modifications of each.

Moreover, a new element has entered into the computation, which has not yet found its way generally into print as a factor in the problem of statistics and mortality; that element is the new operation for stone—litholapaxy. Even Coulson, in his admirable chapter on statistics in his last edition, 1881, hardly mentions it. Enough material in this line has not yet been collected to seriously affect old statistics, but that it is an element which must modify them cannot be denied.

Much reiteration of well-known facts and figures is unprofitable, and I shall content myself with as small a display of tables as possible, reserving the practical consideration of the relative efficacy of the different methods for the section of this article which considers the choice of an operation as regards: (1) the peculiarities of the patient; (2) the peculiarities of the stone.[1]

LITHOTOMY.—The phenomenal success of Martineau,[2] 2 deaths in 84 cases, and that of Pouteau,[3] 3 in 120, are apparently the best on record for lithotomy among the older records. It is a success to be aspired to, but rarely reached, although not quite as brilliant as it looks, since less than one-third of Martineau's patients had reached fifty years. Only eleven were over sixty, and both the deaths occurred among these eleven. Alan P. Smith[4] has recently reported still better figures, 52 consecutive cases of lithotomy without a death, 7 of the patients being between 40 and 71 years of age.

Dudley, of Kentucky, is reported to have operated one hundred times consecutively without a death; but this evidence is not founded on personal, written notes. Cheselden,[5] the father of the lateral operation, cut 213 times, averaging 1 death in 20 for all ages; a superb result, and showing only 1 death in 35 under the age of 10. The late S. D. Gross, of Philadelphia, cut, all told, 165 patients, with 14 deaths: 72 of these were children, with 2 deaths, 1 in 36; 93 adults gave 12 deaths, 1 in 7¾.[6] Gross,[7] out of 2303 American cases of lateral lithotomy at all ages, finds 156 deaths, 1 in 14¾. A collection by the same writer of 2711 European operations gives a mortality of 278, 1 in 9¾.

Gross's general table[8] shows 13,570 operations at all ages, and by all cutting methods, with 1549 deaths, an average of 1 in 8.76. This would necessarily be a low average, since it includes all operators and all operations without selection, and pays no attention to the patient's age; but it must not be forgotten that many fatal cases fail to get recorded. It may be considered an excellent average if a general surgeon has a mortality no higher than 8 per cent. in his operations, 1 in 12½ cases, without regard to age or selection.[9] Morton's tables, showing the mortality of lithotomy in the Pennsylvania Hospital at the hands of all operators, over a period of 122 years, give 1 death in 7 cases.[10]

This method of reasoning by general statistics leads to a general conclusion, and has no value when applied to a special case or set of cases. Here the element of age comes in most prominently.

Thompson's table, in this respect, as establishing a general average of mortality for the various ages, is full of value. It has never been practically contradicted by an array of figures from varying sources of equal weight and authenticity, and it is to-day a reasonably fair standard by which any one

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[1] See page 211, *infra*.

[2] Med.-Chirurg. Trans., vol. xi. p. 402. 1821.

[3] Quoted by Gross, op. cit., 3d ed., p. 276. 1876.

[4] Trans. of Med. and Chir. Faculty of Maryland, April, 1878. Reprint.

[5] Cheselden's Anat., 5th ed., p. 322 *et seq.* 1740.

[6] Am. Journ. Med. Sci., July, 1884, p. 305.

[7] Op. cit., p. 275.

[8] System of Surgery, 6th ed., vol. ii. p. 736. 1882.

[9] A very recent table by Nishan Altonnian, of Turkey in Asia (Am. Journ. Med. Sci., July, 1883, p. 151), of 272 lithotomy operations, shows only 15 deaths, 1 in 18.13:—

Under 10 years,	47 cases,	1 death.
Between 10 and 20 years,	99 "	4 deaths.
" 20 " 30 "	66 "	2 "
" 30 " 40 "	38 "	2 "
" 40 " 50 "	23 "	4 "
" 50 " 60 "	6 "	0 "
" 60 " 80 "	3 "	2 "

[10] Surgery in the Pennsylvania Hospital, p. 140. 1880.

may measure the grade of his own success in cutting for stone. The table includes 1827 cases furnished by a great number of operators:—

From	1– 5	years	1	died	out of	(about)	every	$14\frac{1}{3}$
"	6–11	"	1	"	"	"	"	$23\frac{1}{2}$
"	12–16	"	1	"	"	"	"	$9\frac{1}{2}$
"	17–20	"	1	"	"	"	"	7
"	21–29	"	1	"	"	"	"	8
"	30–38	"	1	"	"	"	"	$10\frac{1}{2}$
"	39–48	"	1	"	"	"	"	6
"	49–58	"	1	"	"	"	"	$4\frac{3}{4}$
"	59–70	"	1	"	"	"	"	$3\frac{3}{4}$
"	71–81	"	1	"	"	"	"	$3\frac{1}{6}$

This shows that the safest time to cut for stone is after babyhood and before puberty. Next in order comes the infant age—below 5. Puberty has a depressing influence. Mature manhood gives better results, and after sixty, about one patient in every three and a half dies if cut.

Coulson's[1] table (in decades) of 2972 cases furnished by Castara, Smith, Crosse, Cheselden, Dupuytren, and South, gives a somewhat similar result. I have arranged it so that it may be compared with Thompson's:—

Age.			Death rate. Coulson.	Thompson. Death rate.
From	1–10	years	1 to 13.08	1 to about 18.91
"	11–20	"	1 " 10.28	1 " " 8.25
"	21–30	"	1 " 6.61	1 " " 4.00
"	31–40	"	1 " 5.83	1 " " 10.50
"	41–50	"	1 " 4.50	1 " " 6.00
"	51–60	"	1 " 3.65	1 " " 4.75
"	61–70	"	1 " 3.23	1 " " 3.75
"	71–80	"	1 " 2.71	1 " " 3.16

These figures are undoubtedly good standards to go by. Much better results with children have been achieved by individuals, and even in general hospitals. And much worse results are recorded of brilliant operators, but, in the main, the average of these figures has gone unchallenged. They relate to the *lateral operation.*

The weight of the stone—other things being apparently equal—has a distinct bearing on the mortality of lithotomy, as shown by the very interesting tables compiled by Gross[2] from the 1327 cases of calculus tabulated by Crosse, of Norwich, and by Garden, of the Saharunpore Dispensary. When the stone weighed less than—

1 ounce there was			1	death in	11.01	cases.
between 1 and 2	ounces	there was	1	"	6.55	"
" 2 " 3	"	"	1	"	2.72	"
" 3 " 4	"	"	1	"	1.75	"
" 4 " 5	"	"	1	"	1.83	"
" 5 " 6	"	"	1	"	3.50	"
" 6 " 7	"	"	1	"	1.	"

Claims of superiority for one cutting operation over another have been made on the ground of facility of execution (high operation), anatomical reasons (median), safety (perineal lithotrity), size of the stone (bilateral, vesico-rectal). Statistics of these operations—other than the lateral—are of only secondary importance.

The *high operation* is confessedly very fatal, although at present it is growing in favor in this country, through the advocacy of Dulles, of Philadelphia, and in Germany and France under the influence of Petersen, Ultzmann, Albert, Dittel, Langenbuch, Guyon, Périer, Bouley, Monod, and others. The general mortality seems to be about one in three and a half (Dulles[1] gives 636 cases, 182 deaths, 1 in 3½). Frère Côme had 100 cases and 19 deaths, 1 in 5.27, an excellent showing; but of these 59 were in females, with 9 deaths, 1 in 6.55, and 41 in males, of whom 10 died, 1 in 4.10. Souberbielle had 90 cases with 31 deaths, 1 in 2.90. Of his patients, 6 were under 20 years of age, and 2 died, 1 in 3. Therefore 30 per cent. of deaths is a fair average of mortality to accord to the operation as formerly practised, as far as statistics are a guide.

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[1] Op. cit., p. 523.

[2] Practical Treatise on Diseases, Injuries, and Malformations of Urinary Bladder, etc., p. 278.

It can be shown that modern statistics under the very best circumstances are but little better. Individual sets of small numbers of cases are not important. My personal statistics are absolutely bad. At the date of my operating, several years ago, the total number of my operations by other methods had been thirty-eight, with one death. Then I operated three times in succession by the suprapubic method, and all my patients died. Two were desperate cases and would have terminated fatally, I believe, under any circumstances, but the other was an excellent case, and ought to have ended in recovery by any method. It was before the day of litholapaxy. The operation was not at all complicated, but the patient died with suppression of urine, high temperature, and uræmia, in two days. No autopsy was allowed. There was no evidence of local mischief, and death undoubtedly came by the kidneys. As against these unfavorable statements I deem it just to array a set of cases communicated to me by letter, the results of which are unsurpassed. Mr. A. Groves, of Fergus, Ontario, Canada, writes me that he has performed the high operation four times successfully.

CASE I.—Man of sixty-three years, weighing three-hundred pounds, who had been a very hard drinker; six stones removed. Five measured one and a quarter inch each in the longest diameter; the sixth, quarter of an inch.

CASE II.—Man sixty-seven years old, much debilitated, stone one and a half inch in diameter.

CASE III.—Boy six years old, mulberry calculus one inch in diameter.

CASE IV.—Man sixty-four years old, twenty-five calculi removed.

Truly a remarkable experience, and an excellent showing for the high operation.

Dulles's[2] statistical report, in April, 1878, gives a table of 20 cases as having occurred in the 10 years just preceding, with only two deaths, 1 in 10. But an analysis of the table shows that the average age of the patients was under 16 years, and that the two deaths were in infants of 4 and 2½ years. Further, a foot-note says that two operations are left out of the computation because they were complicated by having had the lateral perineal operation done upon them at the same time with the high operation—yet another look at the table makes this reason hardly a good one, since it is observed that the table contains two successful cases in which this same double operation was done (Billroth's and Watson's), and a suspicion is excited that the two cases left out may perhaps have had a fatal issue, in which event the mortality would be 4 in 22 cases, 1 in 5½.[3]

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[1] Personal letter, and Gross's System of Surgery, 6th ed., vol. ii. p. 759.

[2] Am. Journ. Med. Sci., April, 1878, p. 394.

[3] Replying to a letter, March 29, 1884, Dr. Dulles says that he has collected nearly 700 cases; but he does not mention the death-rate, referring to the figures in Gross's Surgery, 1 in 3½, as his last utterance. He adds further, in explaining the construction to be put upon his table here referred to: "The two cases omitted were fatal. I omitted them because, while it is certainly right to credit the suprapubic method with success where it has been complicated with another

Finally, the very best operation scientifically, that now practised in France—the Petersen-Guyon-Périer operation, done antiseptically with drainage, etc.—shows according to Villeneuve,[1] in the 21 cases reported, a mortality of 30 per cent.—no better than that of the general table first constructed by Dulles, and including the figures of all operators. Guyon's[2] 8 operations yielded 3 deaths, 1 in 2.66. As a final contribution to statistics, I may cite the thesis of A. Garcin,[3] of Strasbourg, 1884. He collates the published operations of suprapubic cystotomy during the years 1879–1883—modern operations—referring for statistics up to 1851 to Günther, and from 1851 to 1878 to Flury. Of the strictly modern operations, 94 were for the extraction of stone or foreign body from the bladder. Of these, 23 died, 24.40 per cent. as follows:—

Age.	No. of Cases.	Ratio.	Percentage of Mortality.
1–10	22	1 : 4.40	22.72
10–20	26	1 : 26	3.84
20–30	8	1 : 4	25.
30–50	7	1 : 7	14.28
50–70	16	1 : 2.28	43.75
70–90	11	1 : 2.75	36.36

This is perhaps the best general showing ever made for the operation—but it surely is not very encouraging, and a later exhibit by Tuffier, Guyon's mouthpiece, is a shade worse. He uses Garcin's figures, and adds more recent ones, making 120 operations with a mortality of 27 per cent., and says that in the 22 cases, all told, since 1879, in which suture of the vesical walls has been resorted to, the suture has failed 20 times.[4]

Since, however, this operation is often reserved for the most severe cases, its apparently bad showing does not possess all the significance it appears to have. This becomes more evident from a glance at the comparative results of the lateral and high operations when the weight of the stone is taken into consideration, as very clearly set forth in the following excellent table prepared by Gross.[5]

	Lateral operation.		Suprapubic operation.	
	No. of cases.	Rates of death.	No. of cases.	Rates of death.
Under ℥j	529	1 in 11.25	14	1 in 4.66
℥j–ij	119	1 " 6.61	21	1 " 5.25
℥ij–iij	35	1 " 2.18	14	1 " 3.50
℥iij–iv	11	1 " 1.57	19	1 " 3.16
℥iv–v	5	1 " 1.66	16	1 " 2.28
℥v–vj	2	1 " 2.00	11	1 " 2.75
℥vj–vij	2	1 " 1.00	2	1 " 2.00

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hazardous procedure, it is, equally, unjust to deduct from its credit any case where such complication was followed by death. The former is undoubtedly a recovery from the operation, the latter cannot be charged to either method."

[1] Rev. de Chirurgie., Sept., 1883, p. 665.

[2] Ann. des Mal. des Org. Génito-Urinaires, Déc. 1882, et Janv. 1883.

[3] Contribution clinique à l'étude de la cystotomie suspubienne, etc. Ann. des. Mal. des. Org. Génito-Urinaires, Juin, 1884, p. 360.

[4] Certain foreign bodies are manifestly appropriate for removal by the high operation. Donnel Hughes (Phila. Med. Times, Dec. 15, 1883, p. 207) reports the successful removal of a steel bonnet-pin with a glass head. I find in the Philosophical Transactions (Abridged, 4th ed., 1731, Obs. 83, p. 162), the record of an amusing as well as instructive case. One Dorcas Blake, in 1694, was cut by Mr. Proby above the pubis to extract an ivory bodkin, four inches long. He cut outside the rectus muscle, and, as he very candidly confesses, "by God's great blessing, she was perfectly cured." The interest in this case is increased by the fact that this "full-bodied, sanguine maid, about 20 years old" went before the Lord Mayor, June 10, 1695, and swore that she had swallowed the bodkin; and her doctor believed her, although her vesical symptoms had appeared within a very suspiciously short time after the alleged swallowing.

[5] Op. cit., p. 296.

This table clearly goes to show that the larger the stone, the safer relatively to the lateral section is the high operation. But it shows with still greater force and clearness that *the high operation is not applicable to stones under one ounce in weight* (and the majority of stones found in practice weigh less than one ounce), since the mortality of such stones is nearly three times greater for the suprapubic than for the lateral operation.

This criticism is enforced by the unimpassioned eloquence of Billroth, a general surgeon, and therefore a most competent observer and critic, who in speaking of the operation remarks:[1]—

> This operation finds no great favor with me, although formerly when I was fortunate enough to be Von Langenbeck's clinical assistant, I was very much taken with it, and it appeared to me to be the ideal of an operation for stone. The cases of suprapubic operation in children performed by Von Langenbeck's masterly hand, did well eventually, but there was much sloughing of the cellular tissue in the neighborhood of the wound. After the slough separated the wound granulated up well and closed rapidly, but the children always were very ill after the operation, and suffered far more than when subjected to median or lateral lithotomy.

My conclusion from the evidence, therefore, is that the high operation is suitable for the management of very large stones, for encysted stones, for stones complicated by tumors of the bladder, and for certain foreign bodies, but that it is not appropriate for general application.

The claims of the *median operation* have been advocated in this country by Markoe and others, and the operation has been rather more favored in some quarters than the lateral section.

Its statistical showing has also been very good, particularly in this country, but as the operation has been employed mainly with children, and in cases of small stone, these results do not prove its value as a general procedure. The excellent analytical table of C. Williams,[2] of 64 cases operated on at the Norfolk and Norwich Hospital, sets forth these facts quite clearly; for of these operations, those done under the age of 40 showed a mortality of 1 in 14, and of the remainder, done between 40 and 80, the deaths were 1 in $3\frac{3}{11}$, while where the stone weighed over 3 drachms 2 scruples, only one recovery took place—a very large stone of 4½ ounces—and in this instance a portion of the perineum and rectum sloughed, and a permanent perineo-recto-vesical fistula was established.

Williams compares these 64 cases with the last 64 lateral lithotomies done in the same hospital—the mortality in the latter being 8, against 13 deaths in the same number of median sections. This showing, so favorable to lateral lithotomy, should be modified by saying that the average age in the patients submitted to lateral lithotomy was something under 38, while the age of those undergoing the median section averaged something under 45.

The *bilateral* and *recto-vesical* manœuvres are modifications of the lateral and median operations. The former is often appropriate, the latter never. Even in its best showing—Kœnig's table—the mortality is 1 in 5.18 (ages not given), and fistula remained in those who got well in 1 case out of each 6.

LITHOTRITY.—The statistics of lithotrity belong to two groups, one representing the old, the other the modern operation.

Statistics of the former are well known, of the latter not yet fully made up. A collection of lithotrity operations, 1470 in number, by various surgeons, has been made by Gross,[3] with a mortality of 1 in 9.24. In children, out of 21 cases collected by Guersant, 6 terminated fatally, and 62 operations upon children in the Moscow Clinique furnished also 6 deaths—a very bad showing for calculus in the child.

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[1] Clinical Surgery, New Sydenham Society's Translation, p. 276. London, 1881.

[2] Holmes's System of Surgery, 2d ed., vol. iv. p. 1078.

[3] System of Surgery, 6th ed., vol. ii. p. 736. 1882.

Gross's table relates to the old operation, and the figures have at best a very vague significance, for all ages are included, and the cases were often selected. The fact of selection has greatly enhanced the apparent value of lithotrity. Thus Keith and Fergusson in 231 cases of lithotrity lost 21, a death-rate of 1 in 11.55, while out of 296 lithotomies, the same surgeons lost 75, or 1 in 3.94. Again, Gross has compared the results published at date of the lithotrities of Thompson, Brodie, Fergusson, and Keith—637 cases in adult males, with 46 deaths, 1 in 13.84—with the results of lateral lithotomy by various surgeons taken from Thompson's table and covering the same period of life, 723 cases with a death-rate of 1 in 4.82.

While selection of cases may here be accredited with a measure of the success, still the showing is admirable for the old operation of lithotrity in adults.

Coming down to special statistics, Fergusson lost 1 in 9.08; Brodie 1 in 12.77; Heurteloup claimed to have lost only 3 out 69 cases—1 in 23—and he operated at a single sitting;[1] Keith[2] 1 in 18.42. Civiale's well-known statistics claimed a mortality of only 1 in 41.50. But it is well known that he abandoned the operation in ten patients who died, and these, being added, bring his mortality up to 1 in 24, a result certainly good enough to be satisfied with. But the Necker Hospital statistics of Civiale, are those upon which most reliance can be placed, since they were kept by individuals unfriendly to the great lithotritist; and these give[3] for 78 cases 5 deaths, a rate of 1 in 15.60. Thompson's[4] latest figures are 422 lithotrities with a death-rate of 1 in 13; Cadge[5] reports 86 lithotrities with a death-rate of 1 in 10.75. Ivanchich,[6] in Germany, has done very well for the old operation. Out of 300 cases of short sittings, under ether when necessary, he lost in the first hundred 14, in the second hundred 5, in the third hundred 3—in all 22, or about 7 per cent.—the last hundred giving the best showing ever made for old-fashioned lithotrity.

The present showing of litholapaxy is better than this. The operation is in full course of experiment all over the world, and no figures now given will be accurate a few years hence.

Some efforts have been made to collect material from which to generalize:—

Bigelow's announcement of the method appeared in January, 1878.[7] Up to Feb. 15, 1880, I had collected[8] 120 cases at the hands of all operators, with 6 deaths, a mortality of 1 in 20. In November, 1880, the number had only reached 162.[9] Of these, 125 had been operated upon by surgeons who had recorded five or more operations, and might be presumed to be fairly skilful in vesical surgery. The mortality was 5—1 in 25. The remaining 37 operations had been done by surgeons having recorded less than five cases, and among these there were six deaths—1 in 6.16. Gross,[10] in 1882, reported for all operators 312, with 17 deaths—1 in 18.35. Guyon's collection of 590 operations gives 36 deaths—1 in 13.61. (Desnos.) Bigelow's personal statistics up to July, 1884, include 77 cases, of which five were fatal—1 in 15.4, about 6 per cent. In three cases there was an autopsy, showing that a damaged kidney was the cause in two instances. In the other no cause was evident. In the fourth case, pyelitis was undoubtedly the cause of death, though there was no autopsy. In the fifth the cause was not clear. One patient died a month after the operation, and, as Bigelow remarks, the fact is simply that his operation did not save him from impending death by renal disease.

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[1] De la Lithotripsie sans Fragments, etc. Paris, 1847.

[2] Brit Med. Journ., March 20, 1869.

[3] Traité de la Lithotritie, p. 567. Paris, 1847.

[4] Lancet, March 16, 1878, p. 385.

[5] Ibid.

[6] Mein Epilog, achter Sammelbericht von 33 Fallen von Lithotripsie zur Ergänzung meiner Kasuistik auf die Zall 300, u. s. w. Wien, 1881.

[7] Am. Journal Med. Sciences.

[8] Annals of the Anatomical and Surgical Society, vol. ii. No. 6. 1880.

[9] Holmes's System of Surgery. American reprint, vol. ii. p. 885. 1881.

[10] System of Surgery, 6th ed., vol. ii. p. 736.

The two largest stones thus dealt with have been one of 1802 grains—removed successfully in three sittings, and one of 1380 grains, in one sitting of one hour and fifty-five minutes, also a success. Thompson's figures, when recorded for his first hundred and odd cases, showed a mortality of about three per cent. In response to a letter asking for statistics in the spring of 1884, he kindly sent me a digest of his sixth lecture delivered before the Royal College of Surgeons, in June, 1884. In it he deals with the whole subject collectively, giving his statistics from 1860 to 1884. At that time he had performed litholapaxy 191 times, but he does not mention the exact mortality. His general showing is admirable for all operations, 807 operations on 715 individuals. Of these 13 were females, with 1 death; 15 were children, with 1 death; 775 were adult males. Of the latter, 110 were cut, with 39 deaths—1 in almost 3—about 35 per cent.; 665 were operated on by lithotrity, the old and the new operation included, with 43 deaths—1 in 15.5, or under $6\frac{1}{2}$ per cent. Of this total, 775 adult male cases, the death-rate, all told, was 1 in 9.5—and 591 of the patients were upwards of 50 years old. He states further that, in his entire experience, he has refused operation to 6 patients only. This is certainly a remarkable record. Of his last 116 lithotrity operations (litholapaxy), 6 ended fatally—1 in 29 cases, or less than $3\frac{1}{2}$ per cent.

G. Buckston Browne reports to me by letter, that, up to May 8, 1884, he had operated by the new method 48 times with 2 deaths, both in old men, who died uræmic, probably with surgical kidney. Caswell, of Providence, has a small, but perfect record of successful operations for small stones upon ten individuals consecutively, and Chismore, of San Francisco, makes me a similar report orally, having operated upon eleven cases without a death. Dittel[1] adds 50 new cases in 1884, to a former report of 30 cases, the whole yielding him 5 deaths—1 in 16—about a mortality of 6 per cent. Dr. L. A. Stimson, of this city, reports to me a list of eleven successive and successful cases.

My own statistics[2] are briefly these: Total number of operations 52, with 3 deaths. My first 17 consecutive cases were successful; the 18th patient died, after a second sitting, from advanced pyelitis. He had been bed-ridden a year—and, as in Professor Bigelow's case, the operation failed to save him from the natural result of advanced degenerative disease of the kidney. My second death was also due to renal complications—suppression, high fever, uræmia. There was no autopsy. The kidneys were known to be diseased before the operation. The third death can hardly be charged to the operation. The subject was an old hospital patient, a man of 80 years, bed-ridden, with large prostate, chronic cystitis, and damaged kidneys. A small phosphatic accumulation (about half a drachm) was discovered, and removed in less than fifteen minutes. The patient's symptoms became aggravated and he died in a week. My general impression is that the operation is reasonably (but not entirely) safe, even where the kidneys are unsound, and that with perfectly healthy kidneys litholapaxy properly performed is nearly as harmless an operation as passing a catheter.

My collection contains one oxalate-of-lime stone, weighing an ounce, and removed in 32 minutes; a phosphatic stone weighing 765 grains, and removed in 45 minutes; an acid stone weighing 1065 grains removed in one hour and fifteen minutes; each of these at one sitting, and all successfully.

Guyon's statistics are recorded in the thesis of E. Desnos. They comprise 226 cases with 12 deaths. Still more recently, Kirmisson,[3] another of Guyon's pupils, has brought the record up to 1883, adding Guyon's last 70 cases, with 2 deaths. This clearly puts the number of Guyon's operations at the top of the list. He has operated 296 times with 14 deaths, 1 in 21.13, or less than 5 per cent. of mortality, a most admirable showing. P. J. Freyer,[1] an East Indian surgeon, reports 111 cases and 4 deaths, 1 in 27.75—a mortality of less than 4 per cent—which places him at the head of the list of successful operators who have had over 50 cases.

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[1] Wien. med. Wochenschrift, Nos. 3–11, 1884.

[2] In some of my earlier cases Dr. Van Buren did a part of the crushing. He approved the operation heartily, but his failing health prevented him from operating often, and the active work in most of the cases fell naturally to me.

[3] Des Modifications modernes de la Lithotrité, p. 67. Paris, 1883.

The two operations have been compared on four occasions. The Vienna General Hospital for the year 1881 reported:—

Lithotrity 14 cases	1 death
Litholapaxy 22 "	0 "

Thompson, in the sixth edition of his Diseases of the Urinary Organs, reports 112 consecutive cases of rapid lithotrity performed upon elderly men averaging over 62½ years, with 3 deaths, 1 in 37.33. He says that by the old operation his mortality was 7.50 per cent., or 1 in 13.33, and that in his best series of 112 cases he had 6 deaths. In the hands of this able operator, therefore, the new operation has yielded results exactly twice as good as those obtained by the old method.

Billroth,[2] in a paper read before the Vienna Medical Society in 1880, speaks of 41 patients operated upon by himself by old lithotrity; of these, 9 died, seven after the first sitting, two after the second. He had done litholapaxy 7 times with one death, which he ascribed to poisoning by chlorate of potassium. The patient had taken 620 to 700 grains a day.

Guyon, reporting through E. Desnos[3] in a thesis referred to in the Revue de Chirurgie, says that he has practised old-fashioned lithotrity in 73 cases, with 6 deaths, 1 in 12.16; as already mentioned, his modern operations have been 296 in number, with 14 deaths, 1 in 21.14.

Relapse after Radical Treatment.

The question of the number of cases of relapse occurring after radical treatment, deserves consideration in connection with other statistical arguments bearing upon a choice of the method of cure. Mr. Charles Williams, of the Norfolk and Norwich Hospital, has studied this subject very thoroughly. His latest utterance appeared in 1878,[4] and may be taken to represent the state of the case now, as far as concerns old-fashioned lithotrity and lithotomy. The question of relapse after litholapaxy has not yet been made the subject of generalization.

Mr. Williams says that during a period of 97 years, in 935 lithotomies (lateral and median), relapse occurred once in every 33 cases. The recurring stone was not always of the same composition as the calculus which had been removed by the first operation.

In 19 instances the second stone was like the first—10 phosphatic, 9 uric-acid and urate. In 7, phosphates followed urates; in 2, phosphates followed oxalates. This seems to show that there were only 9 cases of true relapse of acid primary stone, for a reproduction of phosphates is simply the return of a physical symptom of a morbid condition (chronic catarrhal inflammation), and as that morbid condition is not necessarily removed by the operation, so the recurring stone may be a relapse not in any possible way dependent on the character of the operation. Where secondary follows primary stone, it is fair to believe that the operation may be at fault in having lighted up a catarrhal inflammation which has become chronic, or in having left a fragment behind. A new nucleus also, in any case, may come down from the kidney after the operation.

From the records of the Charité Hospital, in Paris, it appears that the proportion of relapses after lithotomy was 1 in 11. Civiale, in collecting statistics found for lithotomy in Bavaria 1 relapse in 32 cases, in Bohemia 1 in 56, in Dalmatia 1 in 53. At the Luneville Hospital, the registration of 1592 operations showed 13 relapses, 1 in about 123—Civiale[1] puts it wrongly 1 in 116—and Civiale's[2] general collection of 4446 lithotomies allows 42 relapses—1 in about $105\frac{6}{7}$.

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[1] Lancet, February 28, 1885, p. 378.

[2] Wiener med. Wochenschrift, Nos. 44 und 45, 1880.

[3] Rev. de Chirurgie, No. 12, 1882, p. 992.

[4] Lancet, May 18, 1878.

Against this may be placed the proportion of relapses confessed to have occurred in their own operations (the old one), by the two great lithotritists Thompson and Civiale. The former noted relapse in one of twelve cases, the latter in one of ten.

Hence there can be no reasonable doubt that relapse is far more common after old-fashioned lithotrity than after lithotomy, and this conclusion is supported by inductive reasoning. For the causes of relapse after operation are three: (1) a new renal nucleus; (2) a piece of stone left behind to form a nucleus for the new calculus; (3) damage done by the operation, leaving a catarrhal surface in the bladder which leads to the deposit of secondary (phosphatic) stone. The first of these causes exists equally under all operative circumstances, but in the second and third cases undoubtedly, if the fault exists in the operation, old-fashioned lithotrity must be more exposed to it than lithotomy.

This is not true of modern lithotrity. Phosphatic re-accumulations occur frequently after this operation, but not often because of it. They will be equally frequent whatever is done, if only the causes of secondary stone persist (prostatic hypertrophy, vesical atony, chronic cystitis, etc.). But litholapaxy offers so many advantages in its mechanical execution for detecting and removing a last fragment, that relapse from a neglected fragment after this operation must be ascribed rather to the operator than to the method.

Kirmisson, who in his study of Guyon's 296 operations by the new method has had the best opportunity of speaking authoritatively, says[3] that there have been only 9 cases of relapse noted out of the whole number, and he adds that, if phosphatic re-accumulation be left out of the question, a permanent cure may be always expected.

CHOICE OF OPERATION.

Apart from statistics and the question of relapse, a practical consideration of the question of a selection of a method of cure in a given case requires investigation both as to (1) the peculiarities of the patient, and (2) the peculiarities of the stone.

I. THE PECULIARITIES OF THE PATIENT, as influencing a choice of operation for the cure of stone, are (1) age; (2) the state of the general health; (3) the local condition of the genito-urinary tract.

(1) *Age.*—In the male, before puberty, statistics teach that the cutting operation has heretofore given by far the best results, though litholapaxy is yet on trial. In 1881, two cases were operated on by litholapaxy in Germany:[4] Billroth operated once on a boy of six; some fragments were left, and infiltration and death followed. Dittel operated on the other case, but failed, and had to resort to lithotomy. Guyon[5] was successful once with an infant of four years, upon whom a No. 16 (French scale) tube was used, and Keegan[6]

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[1] Op. cit., p. 695.

[2] Ibid.

[3] Loc. cit., p. 70.

[4] Allg. Wien. med. Zeitung, 29 Nov. 1881.

[5] Indian Medical Gazette, May, 1884.

[6] Rev. de Chirurgie, No. 12, 1882, p. 992.

recently has reported 24 lithotrities in male children. In 7 no tube was used. In the 17 litholapaxies, the patient's age in one was 20 months, in one 2 years, in one 3, in one 4, in five 5, in two 7, in three 8, in one 10, in one 12. These 16 patients recovered. The seventeenth was subjected to three sittings, and died. Small instruments were used, and the time of the operations varied from 4 to 70 minutes.

Such success leaves little to desire, but until more numerous operations are tabulated at the hands of many operators, it will be more prudent for the general surgeon to cut male children before puberty than to attempt litholapaxy.

As to what cutting operation shall be adopted in the child, the advocates of the median and lateral operations both claim the field, but the statistics of the lateral are better than those of the median, particularly for large stones. When the stone is quite small and the bladder not much inflamed, for anatomical reasons the median section is perhaps preferable.

Female children of whatever age may be treated by litholapaxy. The urethra may be dilated, and the straight or curved tube used. I have operated once, upon a girl of four years, with ease and success.

In the male after puberty, until the most remote period of life, there is nothing in the age of the individual which contraindicates litholapaxy, while the mortality under lithotomy is shown by all tables to increase steadily with the patient's age.

(2) *The State of the General Health.*—In case of general disease, it becomes often a serious matter to decide whether to subject the patient to any radical operation, or simply to use palliative measures. No rules can be laid down. The surgeon's general knowledge and experience must guide him. Some distinctions, however, may be made. Thus in diabetes, lithotrity might be justified where lithotomy would be out of the question.

In Bright's disease it may be difficult to make a choice. The existence of moderate, chronic, organic changes in the secreting portion of the kidney does not contraindicate operations upon the bladder, although it somewhat affects prognosis. Advanced renal disease of any kind increases the risk of all operations.

(3) *Local Condition of the Genito-urinary Tract.*—Such conditions are diseased states of the kidney, the bladder, or the urethra. Chronic pyelitis, with dilatation of the ureter and pelvis of the kidney, and with more or less of the accompanying interstitial changes in the secreting substance of the kidney, has the gravest influence in operations upon the urethra and bladder. Moreover, it is a condition not uncommon as a complication of some of the maladies which give rise to stone (prostatic hypertrophy, urethral stricture), and worse than all, it is a malady which often cannot be accurately diagnosticated. Thompson has devoted a chapter to this subject, recognizing its paramount importance, and the difficulty, often the impossibility, of diagnosis.

This condition may be assumed to exist when the general health is poor, the mouth dry, the tongue pasty; when the pus in the urine is more thick and greasy than usual, and settles into a dense solid layer at the bottom of the vessel; when the specific gravity of the urine is light and its quantity not very great; and when there seems to be more albumen in the urine than the pus will account for. Such assumption of organic kidney changes may be made even if there are no casts in the urine, and no pain upon pressure in the region of the kidney, or along the ureter on either side.

When the last-mentioned set of symptoms exist; the diagnosis becomes nearly certain; but in the absence of all of them, kidney changes cannot be said to be absent in any case of prolonged chronic cystitis in a patient beyond middle life, for they may be present without any especial distinguishing signs, the urine having only those qualities that belong to the urine of chronic cystitis.

When, therefore, chronic pyelitis is present, what is to be done? Such a complication does not absolutely contraindicate an operation upon the bladder, but it calls for special care in the preparation of the patient, and in the conduct of the operation. These are the cases which furnish the bad attacks of urinary fever after operation, and that desperately fatal sequence known as surgical kidney. Fortunately, however, all cases of chronic pyelitis do not yield serious complications after an operation upon the bladder. I believe that the following case is conclusive in bearing out this statement:—

A gentleman of 57, with vesical calculus, was brought from Massachusetts by Dr. Paddock, of Pittsfield, to Dr. Van Buren and myself. I operated upon him Dec. 11, 1878, by litholapaxy, removing two and a half drachms of stone, phosphatic about a uric-acid nucleus. No chill, no accident whatsoever marred a prompt recovery, and the patient returned home after a few days. He came back in three months for confirmation of his cure, and a search proved the bladder to be empty. He continued, however, to have occasional attacks of vesical irritability, with pain in the side, especially after exertion, and to pass a little pus with his urine; for he had vesical atony and eight ounces of residual urine which he could only void through a catheter; but his general condition was excellent, he took long walks over the hills, trout-fishing, and was delighted with the result of his operation, although he was never quite well.

On Dec. 8, 1880, three years after the operation, he died. Dr. Paddock wrote . . . "He seemed in his usual health until the evening of Dec. 1, when he had an attack of renal colic. The pain was relieved in a few hours by an anodyne powder. He had a severe chill on the morning of Dec. 3, followed by pain in the back, with scanty urine containing blood, rapid and weak pulse, quick respiration, and gradually increasing cerebral symptoms. He died comatose on the afternoon of Dec. 8. At the autopsy, the right kidney was found entirely degenerated, one-half of the capsule being occupied by a cyst containing an ounce and a half of fluid, the other half by simply fibrous tissue. The left kidney was double the natural size, intensely congested, its surface covered with ecchymotic spots, some of them as large as a nickel cent, the pelvis and tubules distended with bloody urine, and the upper end of the ureter plugged with a mulberry calculus." The bladder was dilated, with thinned walls. It contained no stone, and the prostate was not enlarged.

This case is very instructive. There were at the time of the operation vesical atony, eight ounces of residual urine, vesical catarrh, and phosphatic stone—yet three years afterwards, at the autopsy, the prostate was not found to be hypertrophied. Hence it is plain that the vesical symptoms were reflex in origin, and due to disease above, undoubtedly to the degeneration of the right kidney. No accident attended the operation, and the patient did well until a new stone of oxalate of lime formed in his left kidney; this stone, by plugging the only remaining duct for urinary excretion, promptly terminated his life. Although kidney disease be detected, still an operation may be undertaken. Of the three methods, a choice may fairly be made in favor of litholapaxy, unless there is something in the condition of the bladder, prostate, urethra, or stone, to call for lithotomy.

The objections to old-fashioned lithotrity are the necessary number of sittings, each one of which involves a separate risk, and the especial danger of exciting acute cystitis by the large, sharp fragments left after the first sitting. The well-known fatality of lithotomy in late life, is probably largely due to the renal complications which so often attend chronic cystitis at that period.

The morbid conditions of the bladder and prostate which influence a choice of the radical operation for stone, are chronic cystitis and tumors of the bladder and prostate. Acute cystitis need not be considered. Although one of the periods of exacerbation of cystitis which usually accompany stone is not a favorable one for operation, yet either lithotomy or litholapaxy may be performed during its existence, with the happiest result.

A rule of old-fashioned lithotrity proves this, for when a given sitting was followed by severe acute cystitis, it was considered good practice to perform lithotomy at once, and thus relieve the bladder of its torment.

Litholapaxy has in view the avoidance of cystitis by attempting to clear the bladder of all fragments at a single sitting; but some years before litholapaxy was invented, Thompson declared that the acute cystitis following a sitting of lithotrity was one of its chief dangers, and proposed, and successfully practised as a cure for acute cystitis complicating lithotrity, a new, long sitting under ether, in which an attempt was made to rid the bladder of all foreign matter. This expedient, although not identical with lithotomy for the same complication, was equivalent in its object and in its effect.

Chronic cystitis of high grade and unusual severity clearly calls for lithotomy—lateral lithotomy—that the bladder may be thoroughly drained and left at rest after the operation. Cystotomy under such circumstances deals with two maladies at once, and the greater risk of lithotomy is more than compensated by the prospect of curing the cystitis, while the danger of acutely aggravating the severe chronic cystitis by the necessarily harsh manœuvres of litholapaxy, makes the latter operation a second choice.

In like manner, if a tumor of the bladder complicates stone, lithotomy is called for, that both maladies may be treated at once. Benign tumors of the prostate belong to the same category; but only when they interfere with the passage of the urine, and are not complicated by atony of the bladder. For if there is atony of the bladder, and the patient is obliged to use a catheter habitually, he gains nothing by cystotomy, and incurs a greater risk to be rid of his stone by reason of the greater gravity of lithotomy in advanced age as compared with lithotrity. When, on the other hand, the expulsive power of the bladder is strong, notwithstanding the prostatic obstruction, then cystotomy is preferable, for the interstitial prostatic tumor may be taken out at the time of the operation; or the outstanding prostatic growth (third lobe or lateral overgrowth) may be cut or twisted away, thus restoring to the patient the lost function of urination. I have operated upon one such patient, who, before the operation, had not urinated for four years, except through a catheter. After the operation the flow occurred naturally. In another case I had a similar, though less brilliant, result. When the prostate is very long and rigid, and the lithotrite and tube pass with considerable difficulty, the risk of damaging the deep urethra may occasionally be so great as to justify a choice of lithotomy.

As far as the *urethra* is concerned, most obstacles to the free passage of large instruments may be overcome by preparatory treatment, or as a part of the final operation; but serious organic stricture of the deep urethra is a complication which justifies lithotomy—preferably the median or the mediolateral operation—that the stricture may be dealt with by perineal section as a first step in the lithotomy operation. Dolbeau's perineal lithotrity is also applicable to these cases.

II. PECULIARITIES OF THE STONE AS INFLUENCING A CHOICE OF OPERATION FOR RADICAL CURE.—The stone itself influences the choice of operation only by its size or by its position in the bladder. A very small stone, but one too large to be washed out through a tube with the washing bottle, is suitable for old-fashioned lithotrity, without ether. The number of stones does not influence the choice of operation in any way: it simplifies rapid lithotrity, and very much lessens the danger of lithotomy, relatively to the total size of the calculous mass. Nor does the composition of the stone enter into the question, excepting only in the case of oxalate of lime. An oxalate-of-lime stone, if quite large, may successfully resist the lithotrite. I was present at an operation upon a stone of this sort, in which the handle of the lithotrite broke, and the patient was thereupon successfully cut. But an oxalate-of-lime stone, one inch in diameter, may be very readily crushed. I have one such stone in my collection, weighing an ounce, removed in thirty-two minutes.

A stone may, however, have for a nucleus some foreign body which cannot be properly dealt with by lithotrity, such as a bit of wax, a glass tube, a piece of lead or iron (from gunshot wound), or a bit of silver catheter. I saw a piece of wax removed by Dr. George A. Peters through a Bigelow tube, and I have crushed and removed by the washing bottle a piece of soft rubber catheter which had formed the nucleus of a phosphatic stone.

But a stone may be so large that it cannot be grasped by the lithotrite, or it may be small enough to be grasped, and yet, being composed of oxalate of lime, it may fail to break. Then plainly lithotomy is the alternative.

Again, a stone may be lodged in some out-of-the-way pouch, as in a hernia of the bladder, or may be encysted and inaccessible to the lithotrite. Here the choice is palliation or lithotomy.

If the foregoing line of argument be correct, it is fair to conclude that to lithotomy must be given—

1. All male children before puberty.
2. All cases complicated by very severe, chronic cystitis.
3. Cases of tumor of the bladder complicating stone.
4. Some cases of prostatic overgrowth, not complicated with atony.
5. Some cases of very large prostate through which instruments cannot readily be made to pass.
6. Cases complicated by severe, deep, urethral stricture.
7. Cases of very large or very hard stone.
8. Cases of encysted stone.
9. Cases of certain foreign bodies.

All other patients who are proper subjects for radical operation may be best dealt with by lithotrity—very small stones possibly by the old-fashioned operation without ether, perhaps with cocaine, but all other calculi by litholapaxy.

Causes of Death after Lithotomy and Lithotrity.

These are shock, hemorrhage, urinary fever, exhaustion, peritonitis, pyæmia, septicæmia, surgical kidney, and tetanus, and will be considered hereafter under the head of complications.

Shock is an uncommon cause of death. In lithotomy the size of the wound is small, the duration of the operation is brief, and no important organs or tissues are invaded. Hemorrhage, formerly more dreaded than other complications, is rarely fatal with the means now at the surgeon's hand, notably the rubber-tampon. Urinary fever may be somewhat guarded against by preparatory treatment. Exhaustion can hardly prove fatal except in a patient with unhealthy organs. Peritonitis, except as accompanying cellulitis, is rare. It is more common in children than in adults, and has been noticed after lithotrity. Pyæmia, septicæmia, and surgical kidney, are the most common causes of death after lithotomy or lithotrity, the first two usually as an accompaniment of cellulitis, caused often by bruising or lacerating the soft parts while extracting a large stone, particularly if the urine be putrid, by infiltration of urine, burrowing abscess, etc. Surgical kidney is a sequence of an ascending inflammatory process, starting as an acute cystitis and terminating as an acute pyelitis, with multiple (bacterial) abscesses in the kidney—the whole culminating in death during coma, with high temperature and suppression of urine.

Pyæmia and septicæmia may be somewhat guarded against by preparatory treatment, directed toward depriving the urine of its putridity and ammoniacal qualities. Surgical kidney cannot be guarded against; it is more than anything else a result of a previously diseased condition of the kidney, and when it occurs it is the most certainly fatal of all the complications of operations upon the bladder. An occasional death by tetanus has been noted after lithotomy.

Preparation of Patient for Radical Treatment of Stone.

If a patient is young, with sound kidneys, a small stone, and a bladder reasonably free from inflammation, the urine being acid, no preparatory treatment is absolutely necessary, and an operation, well executed, is not much more likely to injure him seriously than it would after prolonged preparatory treatment. But the older the patient, the more damaged his organs, the higher the grade of the chronic cystitis, the more ammoniated and putrid the urine, and the larger the stone, by so much the more are skill, time, and attention needed in the preparatory treatment.

This should in the main be the same, whether lithotomy or lithotrity be contemplated. It may be divided into two parts: (1) The general preparation of the patient. (2) The special preparation just before the operation, to be repeated in lithotrity before each subsequent sitting.

(1) *General Preparation of the Patient.*—This consists in attention to the general health, to the condition of the urine, and to the state of the bladder and urethra. The general health may be fortified, if need be, by tonics, the bowels regulated, the diet looked into. As to diet, it is well to encourage the use of milk, both because it is very nutritive and acts as a mild soothing diuretic, and because it is an appropriate article of diet after the operation, and it is well to accustom the patient's stomach to its digestion and assimilation; when ordinary milk does not agree with him, peptonized milk, kumyss, or buttermilk, may be advantageously substituted.

The urine needs careful attention, first to decide whether kidney disease or diabetes exist, and, if so, whether any operation is allowable; and, secondly, as to its alkalinity and putridity.

It has been perfectly well established (Girard,[1] Malherbe,[2] Gosselin and A. Robin,[3] Menzel,[4] and Muron[5]) that normal urine—urine alkaline with fixed alkalies or acid with urates[6]—does not harm the tissues or occasion local inflammation, while urine in ammoniacal degeneration is deadly to tissue vitality. The more putrid and decomposed such urine, the more virulent does it become (swarming as it is with bacteria), and it is not wise to operate upon a bladder containing urine in this condition by the crushing operation, or, if it can be avoided, even by lithotomy. The causes of this putridity in the urine are chronic vesical catarrh, with atony, and the constant presence of residual urine in the bladder. Any grade of acute or chronic vesical catarrh may exist with pus, blood, and even stringy mucus and ammonia in the urine, but positive putridity is only found where such urine is retained for some time in a paralyzed or atonied bladder.

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[1] Résorption urineuse et urémie dans les maladies des voies urinaires. Paris, 1873.

[2] De la fièvre dans les maladies des voies urinaires, Thèse. Paris, 1872.

[3] L'urine ammoniacal et la fièvre urineuse. Paris, 1874.

[4] Wien. med. Wochenschrift, Nos. 81–85. 1869.

[5] Pathogénie de l'infiltration de l'urine. Paris, 1872.

[6] Van Buren and Keyes, Genito-Urinary Diseases, etc., pp. 46, 144. 1874.

Moderate putridity may be noticed occasionally in connection with long standing chronic pyelitis, with distended pelvis of the kidney, but such cases are not suitable for any radical operation for stone in the bladder.

When, therefore, the urine is putrid, preparatory treatment is imperative. The patient should be put to bed, the urine should be rendered dilute and abundant, and the bladder should be washed out with some warm antiseptic solution, the strength being meantime maintained by quinine, tonics, and a suitable diet in which, if possible, milk should form a part.

As diluents, the infusions, extracts, and decoctions of various vegetables (buchu, triticum repens, pareira brava, corn-silk, flaxseed) are of very little value, and gum and elm-bark water of none whatever. Buttermilk among the foods, and benzoic acid, the benzoates, salicylates, and salicine among the medicines, will effect what little is possible by ordinary therapeutic means.

But the stomach objects to the benzoates and often to the salicylates, and the best medical treatment by the mouth will usually be found to consist in a judicious exhibition of some diluent water. Simple rain-water—better if filtered—is generally effective, and this or any other water, when used as a diluent, should be consumed abundantly. Bethesda water (Dunbar's Spring), Poland water, Glen Summit, Clysmic, Mountain Valley (Arkansas), Wildungen—these are types of the waters which are most suitable, being bland diuretics, easily assimilated, and not owing their value to any especial mineral ingredient. They are little better than rain-water, and if stale are not as good, but they are easier to obtain in large cities, and are more readily assimilated by some stomachs.

Direct treatment by injection is more efficacious than any other means. As these patients with putrid urine usually suffer from vesical atony or paralysis, the catheter may be already in use. If not, the practice of drawing off the urine must be instituted with all the customary precautions, such as not emptying the bladder entirely at the first sitting, etc. Water at a temperature of about 100° F., and containing a tablespoonful or more of borax to the pint, may be injected through a soft catheter, preferably with a fountain syringe. The French use habitually a four-per-cent. solution of boracic acid. A double-current catheter should not be used. A bladder cannot be well washed unless it is moderately distended, so that its folds may be obliterated, and such distention is not effected by the double-current catheter. Mild solutions of permanganate of potassium may be used, or a one-per-cent. solution of carbolic acid. Two-per-cent. solutions, as well as all corrosive-sublimate solutions, have proved irritating in my hands. Dilute lead-water; mild solutions of sulphate of zinc, from three to ten grains to the pint; of nitrate of silver, half a grain to the ounce, slowly increased in strength; or other similar solutions, may be used. An excellent injection is the dilute nitric acid, from one to sixty minims in the pint of water. Borax and nitric acid have given better results in my hands than the other injections mentioned.

If the urine is not putrid, and in any case where there is no atony and no residual urine, it is doubtful whether vesical injections do any good. Yet often under these circumstances the bladder is highly inflamed, and manifestly not ready to be interfered with. The urine is full of blood, pus, or stringy mucus, and perhaps fever runs high. Such conditions are to be treated as in other cases of cystitis. Alkaline draughts (citrate of potassium), anodynes—preferably by suppository, a little belladonna being combined with opium—and rest in bed, with hot hip or full baths, and hot local fomentations, are the most important remedies.

If, after reasonable time and effort, the putridity of the urine cannot be overcome, or the intensity of the cystitis subdued, then, if any operation is to be done, it must be lithotomy, which not only extracts the offending foreign body, but also drains the bladder, leaves it at rest, and thus affords the best chance for recovery from the cystitis, provided that the cystotomy itself be sustained.

(2) *Special Preparation just before the Operation.*—This preparation is more or less rigorous in detail according to the especial requirements of each case. For a child little or nothing need be done, but in the case of an adult, however seemingly well, no harm can result from taking precautions. The preparation is the same for lithotomy and lithotrity, and is to be repeated before each sitting of the latter, if more than one be required.

On the morning of the day of operation the patient should remain warm and quiet in his bed, his bowels should be evacuated, and his stomach should be kept empty, if an anæsthetic is to be used. At about three hours before the time of operating he may take ten or fifteen grains of quinine. A few drops of the strong tincture of aconite is thought well of in some quarters, to ward off shock and prevent chill. I have reaped most success in this line from the combination of pilocarpine and morphia. This may be given by the stomach a half hour before operating, but it is more effective if administered subcutaneously just as the operation terminates. The amount of morphine is to be varied from one-sixth of a grain upwards, if the patient has been accustomed to use it. Of the muriate of pilocarpine I find a dose of from a tenth to a sixth of a grain ample to produce physiological effects, and I believe it to be quite potent in warding off chill.

Before lithotrity, besides all the above-mentioned points of preparatory treatment, the urethra should be gauged to see that there is no obstacle to free instrumentation. The meatus may be attended to at the time of final operation. Anterior stricture should be cut, deep stricture dilated. If dilatation is impracticable, lithotomy should be performed, and both maladies dealt with at once. It is doubtful whether the old-fashioned practice of "training the urethra" by the use of sounds passed at intervals is of any value. The risk of exciting complications when the deep urethra is irritated by the presence of stone in the bladder is great, and local sensitiveness of the urethra, if ether is not used, may be so moderated by the preparatory injection of a four-per-cent. solution of cocaine, that it has become unnecessary. The calibre of the urethra must be determined, but nothing more. In lithotrity and in litholapaxy it is good practice, if the urine is at all foul, to draw it off just before the crushing is commenced, and substitute pure water or borated water, in which to do the crushing.

LITHOTRITY.

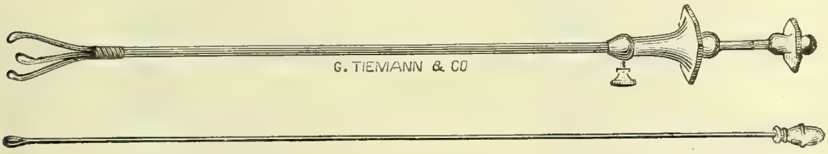
All lithotrity, even that known as the old-fashioned operation, is of modern origin. Surgery owes to the genius of France, and to the present century, all that is valuable in this admirable operation. In 1817 the instruments were devised by Civiale, with which he proposed to break up a calculus within the bladder, and in 1824, before a special committee appointed by the Academy of Medicine, he operated successfully upon two patients. This is the first systematic and scientific attempt at lithotrity recognized by history. The term lithotrity is etymologically inaccurate, but usage has earned it a fixed position in classical nomenclature. The most probable derivation is from λίθος, a stone; τερέω, I pierce; and in this sense the term was entirely apposite, as far as the first operations were concerned, for in them the stone was first seized and then perforated by a drill, before it was finally crushed. For the operation at present used, either lithotripsy (grinding a stone) or litholasty (breaking a stone) would be more accurate.

Scattered records of various efforts to relieve the bladder of stone without the use of the knife, existed in medical history long before the days of Civiale. The first instance seems to have been that of the monk Theophanes, early in the ninth century. Albucasis, in Arabia, appears to have been acquainted with lithotrity, at least in theory. The monk of Citeaux is usually referred to in this connection, and, finally, Colonel Martine[1] with his file, made of the end of a knitting needle, well tempered and set in a piece of whalebone as a handle. With this rude tool, pushed through a straight canula, the colonel was wont to rub his stone away, repeating his sittings sometimes twice a day, and often operating in the presence of witnesses. In this manner he finally entirely relieved his bladder; but nobody has testified to the size of the stone or the weight of the débris.

The Bavarian surgeon Gruithuisen[2] seems to have conceived the idea of lithotrity in 1809. He published his views in 1813, establishing the possibility of catheterization by a straight tube, and proposing to introduce through this tube a variety of instruments to act upon the stone: a lance-shaped drill, with a wire snare to hold the stone in place; a trephine; a crow-bill forceps to crush the débris; a stone cutter, etc., of all of which he gave plates; but there is no evidence to show that these instruments were ever actually constructed, much less put to the test, even upon the cadaver.

In 1818 Civiale, being then a medical student, presented to the medical faculty an essay upon a new *lithontripteur*, but it was an instrument never used, and apparently not very suitable for the work for which it had been designed. During all this period there seems to have been great activity in the surgical world upon the stone-crushing question. Fournier de Lempdes, in 1812, constructed some special instruments, and tried them on the cadaver at the St. Louis Hospital, in Paris. Elderton, in Scotland, constructed a curved file to be used to wear away a stone. Amussat made some efforts before a commission of the Academy, but his instrument unfortunately broke during the sitting. Leroy d'Étiolles devised an instrument to saw the stone, and Ducamp another, which was tried upon the living subject. Finally, Leroy d'Étiolles perfected a forceps with three branches and a saw (*lithoprione*), in April, 1823, and in the following January, 1824, Civiale's *litholabe* (Fig. 1200), a three-branched forceps with drill, was successfully used upon a living patient. Leroy d'Étiolles[3] confessed that he had obtained the idea of his *lithoprione* from a three-bladed forceps (*tire-balle*) of Alphonse Ferri.

Fig. 1200.



Civiale's litholabe.

Attempts at improvement and modifications of the *trilabe* now became numerous on all sides. Even Civiale attempted a modification, but no practical advantage was obtained, and all efforts had the same direction and the same general idea, namely, that it was necessary first to weaken the stone by multiple perforations before it could be successfully crushed.

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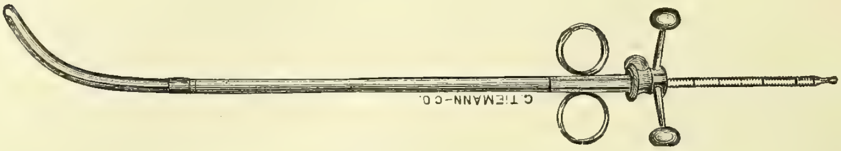
[1] Journal of Science and the Arts, vol. i. p. 199. 1817.

[2] Art. Lithotritie, Dict. de Méd. et de Chir. Pratiques, tome xxi.

[3] Exposé des divers procédés jusqu'à ce jour pour guérir de la pierre, etc. Paris, 1825.

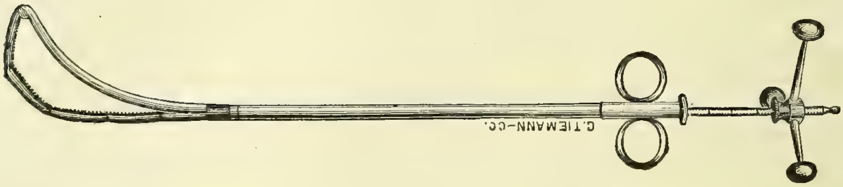
To Jacobson, a Danish surgeon, is due the credit of demonstrating, in 1831, that stones of considerable dimensions might be crushed by simple pressure, without previous perforation. His instrument, the mechanism of which is sufficiently clear (Figs. 1201 and 1202), did very well for the first crushing, but it was difficult to pick up the broken fragments with the loop, and the smaller the fragments the harder became the task, so that although the instrument enjoyed considerable and well merited popularity, it is no longer used.

Fig. 1201.



Jacobson's lithotrite, closed.

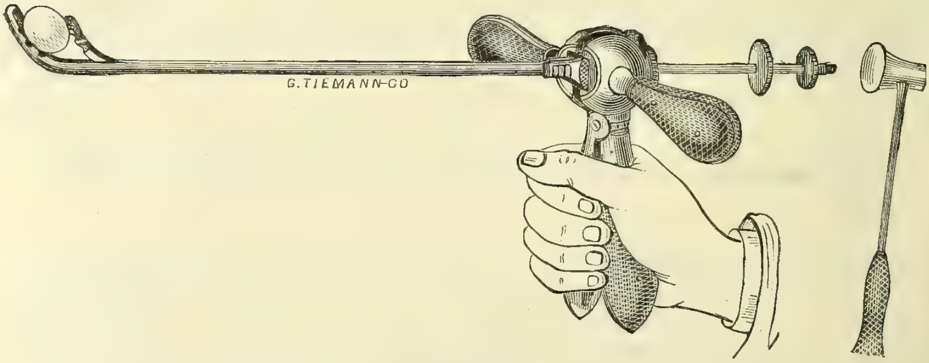
Fig. 1202.



Jacobson's lithotrite, opened.

Meantime attempts to apply the crushing power more conveniently were made in England and in France. Amussat had already, in 1822, devised a straight *brise-pierre*, with which to crush small calculi and larger ones which had been perforated, and Heurteloup at about the same time constructed a *brise-coque;* but the final act of evolving the jaws of the lithotrite, as they exist at the present day, is ascribed by the English to Mr. Weiss, the instru-

Fig. 1203.



Heurteloup's percuteur.

ment-maker of London, in 1824,[1] and by the French to Baron Heurteloup,[2] in 1832. Heurteloup's instrument, the *percuteur*, as perfected, is shown in Fig. 1203. A special couch was used by Heurteloup, by which he changed the position of the patient, and consequently of the stone. He had the stem of his *percuteur* so fixed that no shock should be communicated through it to the patient. Afterwards the table was given up, and the side handles shown in the figure substituted, that the hands of an assistant might receive the counter shock of the hammer and the soft parts of the patient be spared.

The first instrument made by Weiss was simply a curved forceps, its hollow tube containing a small saw destined to divide the stone. In England the names of Stodart, Haygarth, Hodgson, of Birmingham, L'Estrange, of Dublin; on the continent, those of Leroy d'Étiolles, Dupuytren, Touzay, Amussat, Ségalas, and others, swelled the list of those applying useful modifications to the lithotrite.

Screw power in the handle was soon employed to take the place of the Heurteloup hammer. The first actual experiments made with it were at the hands of Hodgson, in the Birmingham Hospital, in 1825, but it was not adopted at that date through fear of damaging the bladder by the fragments, as they flew apart from the jaws of the instrument under the pressure of the screw.

The adaptation to the screw of the rack and pinion by Fergusson, in 1834, finally did away with this fear. Next came the *écrou-brisé* of Charrière, the French instrument maker, in which by a twist given to the handle the screw movement could be thrown on or off at will, and finally the instrument now generally used, which owes its corrugated light cylindrical handle to Thompson, and the sliding button which regulates the screw action to Weiss.

All the lithotrites now in general use resemble each other in their essential features. The jaws are set nearly at right angles to the axis of the shaft. The male blade is more or less roughened; the female blade fenestrated or flat. The old scoop-lithotrites with hollowed blades, whose function it was to bring away as much of the detritus as possible in their bite, after a given crushing, have been discarded. The solid back of the female blade is now only retained that the pulverization of the stone may be more thorough.

All lithotrites possess the light, roughened, cylindrical handle, a screw movement with some mechanism to throw it on and off, and a wheel or rounded handle to work the screw. A marking in centimetres or inches, on the male blade, indicates the extent of separation of the jaws of the instrument. Of the minor variations in shape and detail, there is no end, and they are not

Fig. 1204.

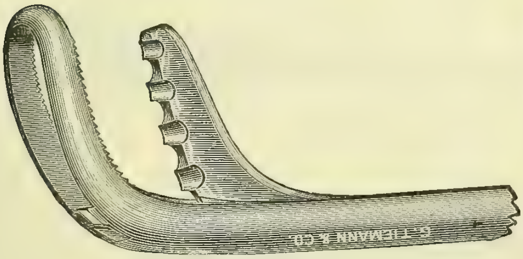
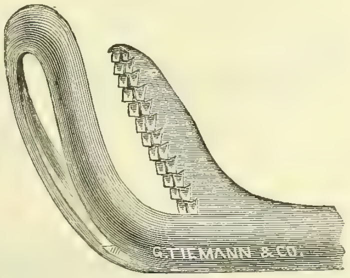


Fig. 1205.



Thompson's fenestrated lithotrites.

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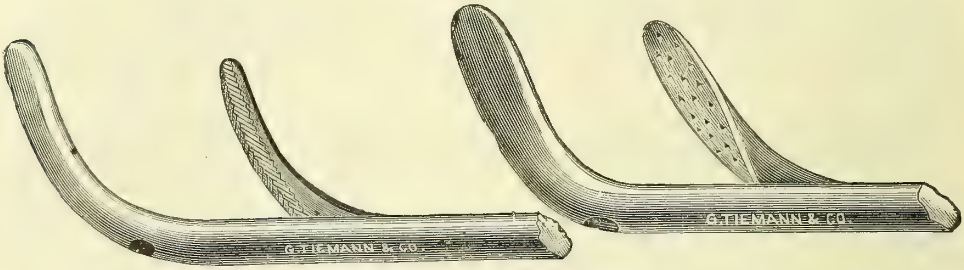
[1] Thompson, Clinical Lectures on Diseases of the Urinary Organs, 6th ed., p. 75. 1882.

[2] Art. Lithotritie, Dict. de Méd. et de Chir. Pratiques, t. xxi. p. 663.

very important. Any good operator can do excellent work with any reasonably good instrument, but no instrument, however good, can be counted upon to perform a good operation unless a good hand is behind it, and, better still, a hand more or less trained to this special work.

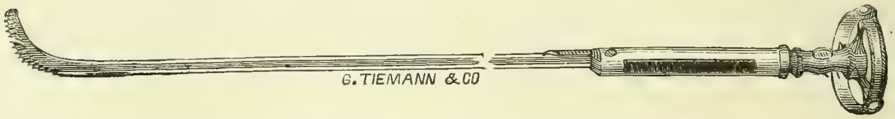
I shall describe only the lithotrites of Thompson and Bigelow, and the instruments which I habitually use. Thompson uses two instruments, one fenestrated to do the heavier work, the other non-fenestrated for ordinary crushing. He employs two varieties of fenestrated lithotrite, that shown in Fig. 1204 being the old-fashioned one, and obviously far less powerful than its younger rival (Fig. 1205), in which the male blade passes entirely through the female. He uses also two forms of non-fenestrated lithotrite. Fig. 1206 shows that used in intermediate work, with reasonably large and hard fragments. Its male blade is narrow and slightly wedged in shape. That seen in Fig. 1207, with its broad, flat male blade is for final pulverization of the fragments. The toughest steel, cut, not forged, is used in the manufacture of all these instruments.

Fig. 1206. Fig. 1207.



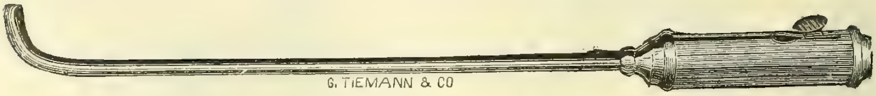
Thompson's non-fenestrated lithotrites.

Fig. 1208.



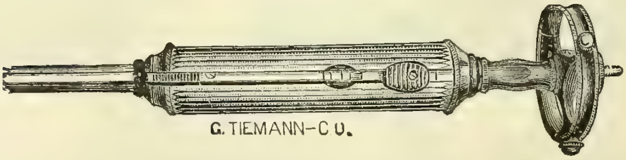
Thompson's lithotrite, male blade.

Fig. 1209.



Thompson's lithotrite, female blade

Fig. 1210.



Handle of Thompson's lithotrite.

Figs. 1208, 1209 represent the male and female blades of the Thompson instrument, when separated, and Fig. 1210 shows the handle closed.

Bigelow uses two instruments of the same pattern, one corresponding in size to about No. 25 of the French scale, the other to about No. 30, at the junction of the shaft with the jaws. (Figs. 1211, 1212.) He says that the spur in the heel, together with the narrowness of the male blade, effectively prevent clogging. The forward curve at the toe of the female blade was devised by Bigelow to facilitate the introduction of a large instrument with long jaws through a large prostate.

Fig. 1211.

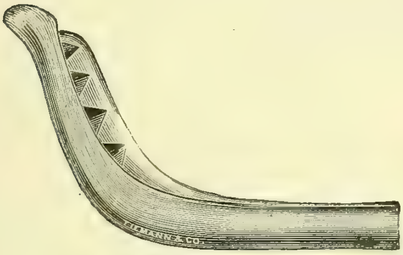
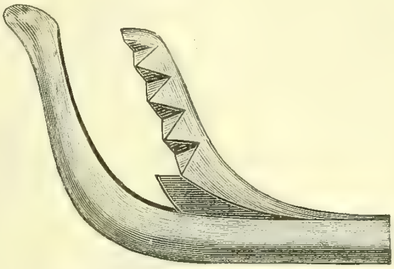


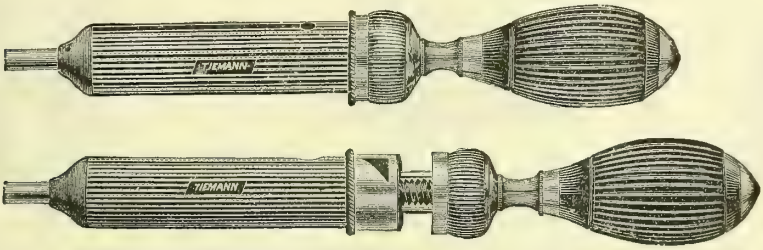
Fig. 1212.



Jaws of Bigelow's lithotrite.

Bigelow believes that quicker and more powerful work can be accomplished by the wrist motion of rotation than by the fingers upon a wheel. Therefore he makes the handle of his lithotrite of solid hard-rubber, and pear-shaped. (Fig. 1213.)

Fig. 1213.



Handle of Bigelow's lithotrite.

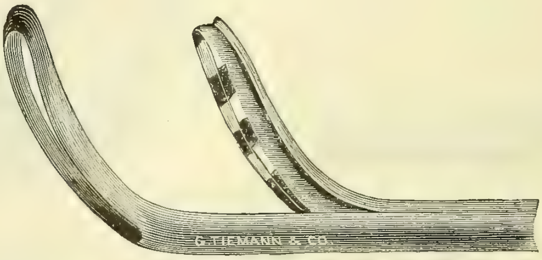
The method of throwing on the screw power in Bigelow's instrument is also an innovation. It is effected by a collar upon the end of the cylindrical handle, and is thrown into action by rotation conformably to the general wrist motion used in manipulating the screw. This instrument is larger and heavier than other models. It is very effective for rapid work, and the male blade is so small, and its asperities are so arranged, that it is with difficulty that a fold of the bladder can be pinched. It requires a little training to work the handle readily.

The instruments which I use are all fenestrated, so that the male blade may be made to pass just beyond the female blade, if necessary. Such an instrument cannot, by any possibility, clog with any substance out of which stone is formed. For litholapaxy there is no object in carrying fragmentation to trituration—small fragments will pass the tube as well as dust, and are less likely to flow back with the return current. For old-fashioned lithotrity a narrow fenestra is all that is required, that the fragments may be made very small; but as long sittings are not allowable with this operation, the non-fenestrated lithotrite is suitable when it is practised.

Coulson uses a fenestrated lithotrite; Billroth and Dittel use Reliquet's, which is partly fenestrated. The German surgeons have modified it slightly. Guyon, who has done more operations than any one else, uses only fenestrated lithotrites, having three sizes, suitable for the various sizes of urethra and of stone.

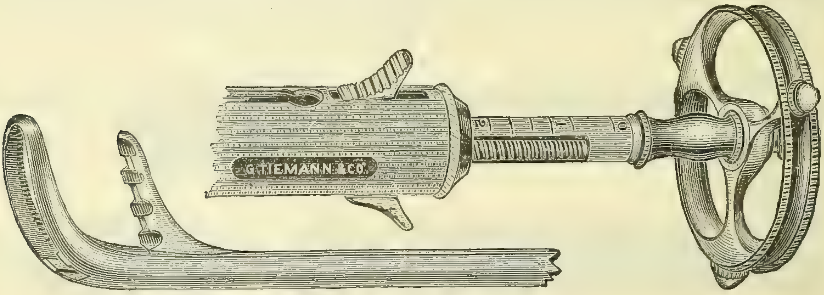
The instruments which I employ are three: Fig. 1214 shows the jaws, and Fig. 1215 the handle, of the larger and stronger instrument. The pattern of the jaws is the same in all. The three sizes are to accommodate variations in the size and hardness of the stone. I prefer the Reliquet pattern of roughening the male blade. The instrument is narrow, but exceedingly strong. It grasps well, and cannot clog. With any reasonable care it is unlikely to catch a fold of the bladder in its bite.

Fig. 1214.



Jaws of Keyes's lithotrite.

Fig. 1215.



Keyes's lithotrite.

For purposes of experiment I have caught up a fold of the bladder in the dead subject with Bigelow's, Thompson's, and my own instrument. It is not difficult to do this, and not difficult to recognize the bladder when caught, nor is it difficult to drop the bladder uninjured after the operator becomes conscious that it is caught.

A few words will account for the creation of my instrument. In 1876, I received from Paris a Reliquet's lithotrite, made by Collin. I was delighted with its grasping power, but the jaws clogged badly the first time I used the instrument, and could not be freed. In extracting them the point of physiological narrowing of the urethra, at two and a half inches from the meatus, was slightly torn, and death from pyæmia followed this one sitting—of the old operation without ether—the calamity being due, in my opinion, entirely to the laceration of the urethra. I had previously scratched a urethra disagreeably, but not mortally, while using a Thompson's non-fenestrated lithotrite, and bringing out an angular piece which could not be dislodged from its jaws. I therefore determined to use always a fenestrated lithotrite, and as the only instruments of that sort then in existence, within my reach, had sharp cutting edges upon the male blade, and were dangerous instruments for rapid use, I simply took the Thompson's non-fenestrated instrument, and had cut in its back a fenestra large enough to allow the sole of the male blade to pass through it. This instrument never clogged; it was almost impossible to catch the bladder with it; and by its aid all my earlier operations of litholapaxy were performed. But it proved by no means large enough or strong enough for heavy work, wherefore I had the back of the female blade cut out of the Reliquet's instrument. This gave great satisfaction, and out of it grew the instrument I use.

I have had one large instrument made with the forward curve at the toe of the female blade, as advised by Bigelow, for ease of introduction; but although this object is attained, yet I look upon the second curve as a disadvantage, because this irregularity in the length of the blades makes it impossible, when the instrument is reversed in the bas-fond of the bladder, to pick up very flat or small fragments. I have demonstrated this on several occasions, using first the lithotrite with the double curve in vain, and then a similar instrument without this forward curve, with prompt success.

In the handle of my larger lithotrite, I have placed two buttons, so that any finger of either hand, in any position, may strike a button easily, and promptly connect the screw. Either button works alone, or they work together. They are saddle-shaped, high, and much easier to work than those of the older models.

All instruments now have the thread of the screw more oblique than formerly, to increase the rapidity of action. I have very materially enlarged the wheel, thus more than making good the consequent loss of power. The larger instrument will lock upon a stone two and a half inches in diameter.

For old-fashioned lithotrity, no instrument except the lithotrite is required, unless it be a searcher, and instruments for removing impacted fragments from the urethra.

MODE OF PERFORMING LITHOTRITY.—All the preliminary steps laid down under the head *Preparation of the Patient* (p. 216), having been attended to, the patient is placed on a hard couch or a table, upon his back, with the head comfortably raised, the shoulders low, and the hips elevated upon a hair cushion, so that they shall be higher than the shoulders. This allows the stone to roll away from the neck of the bladder toward the fundus, and favors the manipulation of the jaws of the instrument at the point of greatest safety, as far as possible from the neck of the bladder. The bladder should contain, if possible, from two to four ounces of fluid, and, unless an operator has accustomed himself to work in a bladder empty as well as full—which it is not difficult to do—a little borated warm water, at 100° F., may be injected through a soft catheter before the sitting commences. If thought proper, the bladder and urethra may first be injected with a four-per-cent. solution of cocaine. The operator stands upon the right side of the patient.

The lithotrite is introduced as if it were a searcher, that is, after its beak passes the hole in the triangular ligament, its heel is made to slide along the membranous urethra and floor of the prostatic sinus by pressing the shaft in the direction of its axis, at the same time that the handle is being slowly depressed. The penis may be pulled upon, or its suspensory ligament relaxed by pressure with the left hand, while executing this manœuvre. The only precaution necessary is not to depress the handle too rapidly, for by so doing the roof of the prostatic urethra might be injured. When the prostate is large, and its urethral segment lengthened, the lateral compression of the urethra by the large prostatic lobes may make its vertical capacity greater than usual, and give the operator the impression that the beak of his instrument is in the bladder while it is still in the prostatic sinus. Sudden depression of the handle at this point is a serious blunder. It may always be avoided by remembering to continue the sliding motion until a lateral turn proves the beak to be free in the vesical cavity, when the handle may be depressed at will.

Once within the bladder, the lithotrite, still closed, is advanced gently until it reaches the posterior wall, and here it usually encounters the stone. The closed jaws are pushed beyond the stone, a tap by rotating the handle locates its position accurately, the beak of the instrument is turned away from the stone without moving the heel from its position, the male blade is withdrawn sufficiently far to seize the stone, whose diameter is known by previous measurement, and then by gentle rotation the open blades are thrown over so as to embrace the stone. The male blade is now pushed in until the stone is grasped, then the button is moved, the screw connected, and at the same moment the whole instrument containing the stone in its grasp is rotated upwards and drawn outwards so as to carry the stone toward the centre of the bladder. If a fold of the bladder has been seized with the stone, this last movement frees it, or at least informs the operator of what has happened.

The stone once safely raised from its bed, the screw power is applied. If the stone is soft, the male blade advances at a uniform rate. If the stone is hard, and badly caught, it shoots out of the bite of the instrument. If it is well caught, but very hard, the screw cannot be turned. There is in such a case a very palpable rebound communicated by the stone to the male blade, which an operator soon learns to distinguish, and judgment about which is the measure of his sagacity, for if he attacks such a stone clumsily he may break his lithotrite and jeopardize his operation.

If the operator concludes that his instrument will not crush the stone, he drops the latter and tries a heavier lithotrite. If he determines to continue, he holds the cylindrical handle firmly, and makes repeated, light, forward and backward motions with the screw in a jerking manner, thus communicating to the stone the effect of a blow as well as sustained pressure, or he may screw the male blade as firmly as he dare, and hold it so until suddenly the stone splits. One of these manœuvres will succeed if the instrument is powerful enough for the stone in question.

The large fragments of the first fracture fall on either side of the closed jaws, but one at least usually drops into the spot where the stone was first seized. The opening and shutting of the jaws is therefore again repeated as before, and again, and again, as many seizures being effected as the patient will tolerate, for presently his power of endurance fails and he demands relief. The jaws being disengaged, and free from débris, the instrument is now gently withdrawn.

The limit of time formerly agreed upon, during which a sitting might be prolonged, was three minutes; and as many seizures as possible were made, perhaps a dozen, enough to crush a small stone completely, or so to reduce it that it could pass the urethra.

Another method often called into play, is to make the stone or fragment gravitate into the jaws of the instrument. This is done by pressing the female blade with moderate force against the back wall of the bladder, while the male blade is held forward.

This position alone may insure success through the action of gravity upon the stone lying loose in the bladder, so that when the jaws are closed the stone will be seized. If the stone, however, does not voluntarily seek the female blade, it may be jarred into position by gently striking the pelvis.

When seized, the stone is carried to the centre of the bladder, and is dealt with as before.

Last fragments are often very difficult to find. The lithotrite may be used as a searcher, tapping various portions of the bladder until a fragment is touched, but when the piece is thus located the tip of the lithotrite must be turned away from it, and the jaws then opened to be again rotated toward the suspected area for the purpose of embracing the stone. If the jaws are opened on the spot where they encounter it, one or other of the blades is pretty sure to displace the fragment.

In old men, the bas-fond behind the prostate may constitute a veritable pouch out of which the stone or fragments will not roll, and the instrument must be made to pick them up within it. This is accomplished by reversing the lithotrite so that its beak looks downward, and commencing at the back wall of the bladder to explore the floor by to-and-fro movements, as the beak is gradually drawn toward the vesical neck. A short-beaked instrument with square tip and broad male blade is suitable for this manœuvre. As soon as a fragment is touched, the beak of the lithotrite is turned away from it, opened, and, returning over the same spot, again closed to grasp it. The operator may now rotate the beak entirely before crushing, or simply move it to one side, to be sure that he has not picked up a fold of the bladder along with the fragment.

In all manœuvres of the lithotrite within the bladder, particularly in the one last mentioned, great care should be employed in every movement, so as to jar, bruise, and scrape the tender soft parts as little as possible.

Subsequent Crushings.—It was formerly the rule in lithotrity to keep the patient in bed after his crushing, and not to operate again until the disturbance caused by the first sitting had subsided; and the same rule is still applicable with all its force when more than one crushing is required. But in these days it is doubtful whether any stone is suitable for old fashioned lithotrity, unless it is so small that it can be easily crushed in two or three seizures. In those exceptional cases, however, where several sittings are required, each subsequent operation is to be performed after an interval of several days or a week, or such time as may be necessary for the bladder to rally from the irritating effects of the previous manipulations.

It must here be remembered that in any case, if the inflammation run high after a given crushing, and considerable calculous débris remain in the bladder, especially if the fragments be hard and large, the proper treatment is to give ether and disembarrass the bladder at once of the offending element by litholapaxy.

After-treatment.—After the sitting, the patient is replaced in his bed, warmly wrapped, with hot bottles at his feet if he has been chilled by the exposure of the operation, and a hot, dry application over the bladder, with perhaps a warm drink (without alcohol). He must not be allowed to pass water except upon his back, or rolled over on his side, during at least the first twenty-four hours after the crushing, and in some cases, if there are to be several sittings, it is better for the patient always to lie down to pass water until the bladder has been entirely emptied of fragments ; otherwise he runs the risk of an angular fragment becoming impacted in the urethra.

The urine should all be strained through a fine sieve or coarse cloth, and the sediment dried and collected for weighing. A suitable anodyne should be administered during several days, and should be pushed if there is any tendency to vesical spasm or inflammation. An alkali or diluent may be given with advantage in most cases. Milk forms a suitable diet. Any chilling of the patient is to be strictly guarded against. After forty-eight hours the patient may get up and remain about, avoiding cold, being careful of his movements while in the erect posture, and lying down, if possible, every time he urinates.

COMPLICATIONS OF LITHOTRITY.—The complications of lithotrity may be divided into two classes, those attending the operation and those following it.

Complications during the Operation.—These are escape of urine, vesical spasm, and hemorrhage.

(1) *Escape of Urine.*—As the lithotrite is being introduced, or after it is fairly in the bladder, whether an anæsthetic has been used or not, the bladder will sometimes involuntarily empty itself, the fluid escaping in a stream alongside of the instrument. It is proper under such circumstances to grasp the penis and compress the urethra about the shaft of the lithotrite, without withdrawing the latter, and after a moment's delay to proceed with the operation. In case this does not suffice, a flat tape may be tied with moderate firmness about the body of the penis, over the shaft of the lithotrite, and the operation may go on; but it is usually better either to finish the sitting with the bladder empty, which may be safely done by an experienced operator using a lithotrite with a smooth male blade, or the sitting may be postponed to a more favorable occasion when the bladder may be less irritable, and the precaution may be taken before this subsequent sitting to administer morphine subcutaneously.

(2) *Vesical spasm* during the operation is a rare but a disagreeable complication. The bladder may be only partly empty, or the spasm may spurt out what fluid it contains, often with an exhibition of decided suffering, if an anæsthetic has been used, and with cries of pain from the patient if it has not; the deep urethral muscles and the vesical walls grasp the lithotrite, and fix it in position so that it can no longer be rotated, and sometimes it is rather tightly retained if an effort is made to withdraw it.

With a bladder in such a mood, further operation is generally impossible. Sometimes the spasm is quite short, and, if the lithotrite is left at rest, promptly subsides and does not recur. Usually, however, it repeats itself, and the prudent surgeon retires his instrument as gently as possible, acknowledging defeat, and promising himself aid from his ally morphia before making the next aggressive move.

(3) *Hemorrhage* during an operation is usually seen only in such drops of blood as, starting from a scraped patch of urethra, ooze forwards along the shaft of the instrument, or in a gush of urine stained with blood forced out by vesical spasm. Such indications, although unpleasant, are not serious, and do not call for a termination of the sitting. Aston Key has recorded a case in which hemorrhage was so severe during attempted lithotrity that it was deemed prudent to abandon the operation and perform lithotomy.

Complications after the Operation.—These are retention of urine, urinary fever, hemorrhage, impaction of a fragment in the urethra, cystitis, epididymitis, and surgical kidney.

(1) *Retention of Urine.*—This is a complication not particularly uncommon after the manipulations of old-fashioned lithotrity. It occurs also sometimes after the longer sittings of litholapaxy. It is due to spasm of the sphincters and cut-off group of urethral muscles, excited by the irritation of the mucous membrane about the membranous urethra. A warm bath, hot fomentations, and an anodyne may relieve it; if not, after moderate delay, it is proper to introduce a small soft catheter.[1] The urine so drawn off will generally

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[1] A silk instrument, recently placed upon the market by Eschman Bros. & Walch, St. Bartholomew's Square, London, seems to be a model of perfection in its way, possessing all the flexibility of soft rubber with far greater rigidity, and a very much higher finish than rubber.

contain more or less blood, and it is wiser before withdrawing the catheter to wash the bladder out with a hot borated solution.

One passage of the catheter may be all that is required—or its use may have to be persisted in for several days. In the latter case, the bladder should be washed after each instrumental withdrawal of the urine, but if there be no retention, vesical irrigation is not called for in ordinary cases.

(2) *Urinary fever* may complicate lithotrity. It is always announced by a chill, and full of uncertainty as to its issue. It may come on promptly, be attended by suppression, and end in speedy death. Generally, if the chill does not occur until near the end of twenty-four hours, the fever will not be very intense, and if its advent is postponed as late as the second twenty-four hours, little harm may be expected from it. Any chill occurring later than forty-eight hours is more likely to portend some graver complication than urinary fever, such as active cystitis or surgical kidney. When a chill occurs it is always a grave matter. Its significance is necessarily involved in doubt. It may be followed only by a slight rise in temperature, with a critical sweat, after which order is restored and no further annoyance experienced, unless perhaps an outcrop of "fever-blisters" on the lips or elsewhere—an appearance always to be hailed with delight as indicating that the worst is over. On the other hand, the sweat following the fever may be delusive, higher temperature may succeed, and pyæmia, cellulitis, surgical kidney, or some other grave complication may follow.

It is presumed that all the precautions to avert urinary fever laid down in the section on preparation of the patient have been taken, but over and above these precautions, if the surgeon is at hand when the chill occurs, a subcutaneous injection of a small dose of pilocarpine and morphia may be given (gr. $\frac{1}{10}$ in ♏ v of Magendie's solution), and a hot drink containing some ammonia or alcohol—more or less, according to the patient's condition. Warm applications of various kinds may then be made, and the remainder of the treatment conducted symptomatically. The patient requires close watching. His temperature should be often taken, and any physical complication which arises to explain the chill dealt with according to its needs. After a chill, the patient should be kept upon quinine, gr. v–xxx daily.

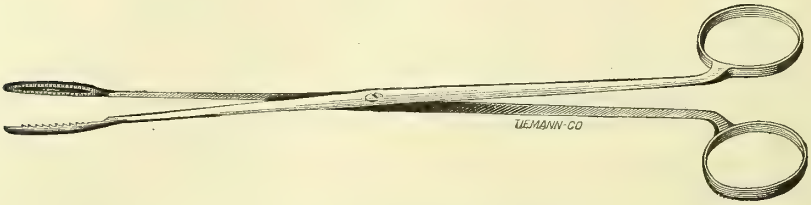
(3) *Hemorrhage.*—Moderate hemorrhage is customary after lithotrity, and need cause no uneasiness. Occasionally it is excessive. Thompson has reported two fatal cases, in one of which villous growths in the bladder were the cause, while in the other a post-mortem examination showed that "the whole mucous membrane of the bladder was greatly congested." Generally the urine ceases to be bloody after a short time, and no special treatment is called for by the bleeding in any case, except an anodyne to quiet the contractions of the bladder, and warm borated irrigation, if retention or atony demands the use of the catheter.

(4) *Impaction of a Fragment in the Urethra.*—This disagreeable accident ought never to occur. If the fragments left in the bladder are not small enough to pass easily, either the operation has been imperfectly done, or the case should have been treated by litholapaxy. But it is possible for a fragment to be left under any circumstances, and urethral impaction may ensue.

If a fragment does become lodged in the urethra, the impaction is likely to take place at the bulbo-membranous narrowing of the canal, more rarely at the middle of the pendulous urethra, or near the meatus. In the first-mentioned situation it gives the most trouble, occasioning sometimes severe pain, and producing muscular spasm of the cut-off muscles even to the extent of causing retention.

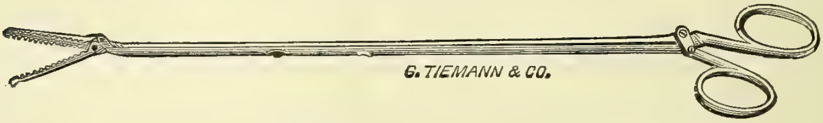
The removal of urethral calculi has already been considered (page 178), and to that section the reader is referred for the different methods of removing foreign bodies from the urethra. Among all the instruments employed, my experience has led me to adopt the divulsor used as a forceps, for the reasons which I have already stated. But this instrument has not been commonly employed. Among those in ordinary use may be mentioned, as having received general sanction, the long urethral forceps (Fig. 1216), and the alligator forceps, straight and curved (Figs. 1217, 1218). My experience with all these instruments is, that they pinch, scratch, and tear the urethra, and that it is difficult with them, often impossible, to seize a foreign body and extract it, especially if the latter be angular and impacted.

Fig. 1216.



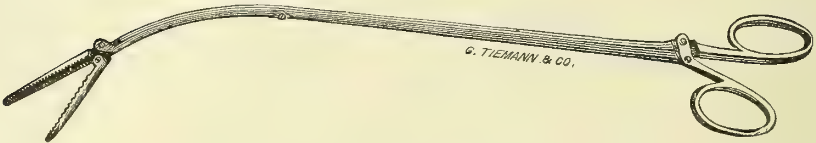
Urethral forceps.

Fig. 1217.



Alligator forceps, straight.

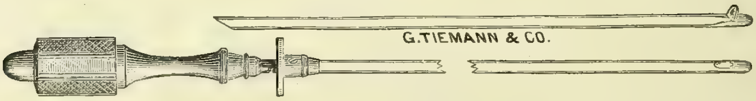
Fig. 1218.



Alligator forceps, curved.

A very ingenious instrument, and one which may serve when the foreign body is impacted far forward, is the articulated scoop of Leroy d'Étiolles. Fig. 1219 represents it—open and shut. The urethral lithotrite is an adaptation of a small male blade to a steel instrument, fashioned like the scoop of Leroy d'Étiolles, and in which the female blade is worked by an analogous mechanism (Fig. 1220). Mathieu, of Paris, has devised an ingenious instrument for reducing urethral stone to fragments. Fig. 1221 shows it, closed for introduction, and at work. The mechanism is in the handle. The stone is caught in the hollow of the closed female blade. Then, by rotation, half the female

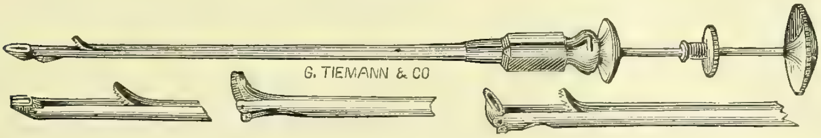
Fig. 1219.



Leroy d'Étiolles's scoop.

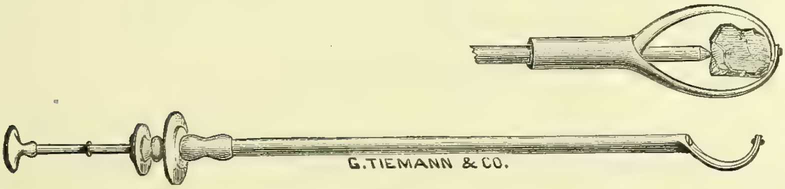
blade goes around the foreign body and incloses it, after which the perforating male blade is advanced.

Fig. 1220.



Urethral lithotrite.

Fig. 1221.



Mathieu's instrument for perforating urethral calculi.

(5) *Cystitis.*—A moderate amount of superficial cystitis was not unusual after old-fashioned lithotrity, if the fragments left after the first crushing were large. It was indeed this well-known tendency which induced the English surgeons present at the meeting of the Royal Medical and Chirurgical Society of London, in 1878,[1] to lean toward the conclusion that lithotrity had been pushed too far; that, except for small stones, lithotomy was a better operation; and that in the future more stones should be cut for, and fewer crushed. And it was partly by reasoning upon the same premises that Bigelow had at about the same date reached exactly the opposite conclusion, namely, that a stone, however large, was suitable for lithotrity, provided that it could all be removed from the bladder at one sitting. Bigelow's solution of the problem was the invention of litholapaxy.

As matters stand to-day, therefore, the question of cystitis after lithotrity is not a serious one. Large stones are no longer dealt with by old-fashioned lithotrity, and much cystitis does not follow upon crushing a small stone. Litholapaxy, on the other hand, leaves the bladder empty, and the most important causative factor of cystitis is removed.

The treatment of cystitis following lithotrity is the same as that of cystitis from other causes—rest in bed, hot applications locally and hot baths, alkalies and diluents by the stomach, anodynes as may be required—with use of the catheter and vesical injections in appropriate cases. If it so happen that fragments of any considerable size are left in the bladder, and that cystitis of a high grade supervenes, the surgeon's duty is plain. He must relieve the tender mucous membrane from the repeated injuries it is receiving from the sharp fragments, and a second thorough sitting of litholapaxy, under ether, and lithotomy, are his legitimate alternatives.

In such serious cases as have sometimes been recorded, where the superficial cystitis is complicated with interstitial inflammation of the walls of the bladder, the formation of abscess, peri-cystitis and para-cystitis, the surgeon must be guided by general principles and meet the indications as they arise. Occasionally, but very rarely, chronic cystitis with a tendency to phosphatic re-accumulation follows lithotrity, even when the stone first removed has been formed of uric acid, and the bladder has been in fair condition at the time of operating. (Thompson.)

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[1] Lancet, March 16, 1878, p. 385.

(6) *Epididymitis* occasionally occurs as a complication of lithotrity. It is due to the damage inflicted upon the deep urethra by the instruments employed, or sometimes to the impaction of a fragment in the urethra. In the case of very old men it may possibly develop into a true orchitis, and the latter may culminate in abscess. I have seen one instance of this complication. Ordinarily, however, epididymitis is a very trifling matter, terminating in resolution in from two to ten days, and only notable on account of the annoyance which it occasions. Its treatment is by the use of hot anodyne applications and local support, the patient remaining in bed. No further sitting of lithotrity should be undertaken until the epididymis and cord are free from any tenderness on pressure.

(7) *Surgical kidney*, fortunately a rare complication, will be considered in speaking of the complications of lithotomy.

Search for the Last Fragment.—The reproach is constantly made against lithotrity that a fragment is often left behind, and that relapse becomes, therefore, inevitable. No patient should be deemed well after lithotrity until his final searching has proved him well, and modern methods of searching are nearly absolute in their conclusions. Phosphatic re-accumulation does occur, but this is not relapse, and does not depend upon the persistence of any nucleus left behind in the bladder.

Such rough methods as making the patient ride a long distance in a vehicle without springs, over a rough road, before calling him well after treatment for stone, are no longer employed; nor is the condition of the urine a trustworthy test, for it may continue to show pus long after the last fragment has been removed. Nor can the searcher be relied upon with confidence, for if even a large stone may sometimes elude the searcher in skilled hands, how much more a minute fragment! The method of to-day, which ranks all others in accuracy, is the use of the washing-bottle, as employed in litholapaxy, with a small metallic tube. It is not much more painful than sounding with the searcher, if the bladder be not over-sensitive; and if it is so used that not a bubble of air is allowed to enter the bladder, there is no test which approaches it in accuracy for detecting a final fragment.

Every patient should be subjected to this test before he is pronounced well, and the test should be reapplied after several months.

LITHOLAPAXY.

Bigelow has chosen this name (from λίθος, a stone, and λάπαξις, evacuation) to indicate his operation for the removal of stone. It is essentially lithotrity with the aim of reducing the entire stone to fragments and removing it through a tube by suction at one sitting, without regard to the amount of time consumed. More than three hours have been thus consumed without any resulting harm. Special apparatus for washing, and various tubes and lithotrites have been devised, in order to execute the manœuvres of the operation more promptly and effectively; but the essence of the operation consists not in the instruments, but in its design—in the method—and litholapaxy might be effected by any lithotrite, a soft catheter, and a piston syringe, if no better implements were at hand.

That litholapaxy has established for itself a recognized position, is plain. In England it has been adopted by Thompson, Coulson, Harrison, and Teevan; in Germany by Billroth, Dittel, and Ultzmann. I have noticed no report from that sturdy old lithotritist of the old school, Ivanchich. In France, Guyon is loud in its praises. In America, Van Buren, Caswell, and a host of others in the States and in Canada, have given it their warmest adhesion, while reports are beginning to come in from other sections of the globe.

J. G. Kerr[1] announces that the operation has taken root in his Missionary Hospital at Canton. P. J. Freyer[2] praises it from India, reporting 111 cases. Zamcarol,[3] from the hospital in Alexandria, Egypt, announces 14 cases with 2 deaths. H. Blanc[4] has made two reports from Bombay, one of six, a second of ten cases, all successful. G. E. Post[5] has furnished a case from Syria. These have fallen under my notice, and doubtless many more have escaped me. It is rare that a word of serious discontent is heard, although minor criticisms on the operation are not infrequent. In France, I believe that the operation has not been warmly received except by Guyon. Reliquet does not approve it.

The history of litholapaxy is that of lithotrity. Indeed, the pioneers of old lithotrity set for themselves the task of freeing the bladder of the débris made by the lithotrite, and invented special spoon-shaped scoops, acting like lithotrites, to effect this object. Civiale's sittings, very long at first, decreased in length as the operator gained in experience, and had become reduced to the conventional two or three minutes when Thompson took up the banner in England. Heurteloup[6] strove to clear the bladder at a single sitting, and publicly announced this to be his especial aim, but he had no anæsthetic, and his methods were rough and did not find favor. Heurteloup,[7] indeed, stated in so many words that it was not proper to crush a stone, and then leave the fragments in the bladder, but that the object of the operation ought to be to free the bladder of all débris and send the patient away cured.

Kirmisson[8] has forcibly brought out the fact that Heurteloup aimed at evacuation fully as much as at crushing, since he proposed a new name for the operation—"Lithocénose" (λίθος, stone, and κένωσις, extraction). Leroy d'Étiolles,[9] before the *Académie des Sciences*, April 27, 1846, announced that he could extract from the bladder at a single sitting a stone thirty-five millimetres in diameter (something over $1\frac{1}{3}$ inch), and at the same meeting boasted of success by the method of immediate extraction in over a hundred cases. Yet this method never gained favor. Anæsthesia had not been discovered. The means employed to evacute the débris were crude and mechanically imperfect. In the hands of the general operator, much damage must have been done which was never recorded, and even the prince of operators, Civiale, gave up the method entirely, reducing his sittings to a very short limit. Heurteloup, before the end of his career, gave up the effort to relieve the bladder in one act, and short sittings repeated at intervals became the universal practice in lithotrity.

Heurteloup went to England and introduced French lithotrity there, and in 1831 he published a book in London on the principles of the operation.

But the champion of English lithotrity is alive to-day. Sir Henry Thompson has done more in his day and generation for the operation than any one except Bigelow, and, indeed, it looked at one time as if Thompson were slowly working up to the method of rapid evacuation now in use, when the unfortunate death of Napoleon III., under a second sitting of lithotrity—which might indeed have been called litholapaxy, for chloroform and Clover's evacuating suction-apparatus were used—with other circumstances, seemed suddenly to divert him from his progressive course. Up to this time Thompson had been teaching and practising longer sittings, more frequent use of anæsthesia, and more constant recourse to Clover's evacuating apparatus. He had also been urging as a proper course, in the event of active inflammation of the bladder following a first sitting, that the patient should be etherized without delay and his bladder at once cleared of débris by the use of the washing bottle, as a proper treatment of the cystitis. Surely this was litholapaxy, but Thompson did not seem to appreciate it or to accept the spirit of the method, for we find him in March, 1878, three months after the appearance of Bigelow's first announcement of litholapaxy, reading a paper before the Royal Medical and Chirurgical Society of London, advocating shorter intervals between the sittings, it is true, but concluding that in future more stones must be cut for and fewer crushed; and that only small stones were suitable for lithotrity—such as could be dealt with in three or four sittings.

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[1] Medical News, April 7, 1883, p. 382.

[2] Lancet, Feb. 28, 1885, p. 378.

[3] Soc. de Chirurgie, 7 Déc., 1881; Le Progrès Méd., 10 Déc., 1881.

[4] Lancet, July 10, 1880, p. 49, and May 27, 1882, p. 857.

[5] Ibid., July 9, 1881, p. 47.

[6] De la lithotripsie sans fragments au moyen des deux procédés de l'extraction immédiate ou de la pulvérisation immédiate des pierres vésicales par les voies naturelles. Paris, 1847.

[7] Mémoire lue à l'Académie Impériale de Médecine de Paris, pp. 301–9. 1857.

[8] Des modifications modernes de la lithotritie, p. 4. Paris, 1883.

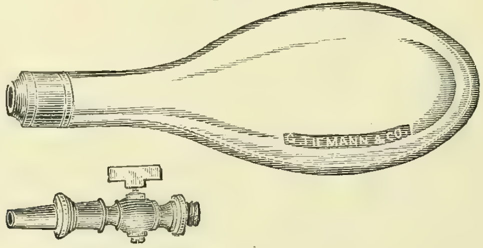
[9] Comptes rendus des Séances de l'Académie des Sciences, t. i. p. 709. 1846; and Gaz. Méd. de Paris, 2 Mai, 1846, p. 354.

Bigelow appears, from his own writings, to have arrived at his perfected operation partly by inductive reasoning and partly by experiment. The views of Otis as to the calibre of the urethra, and the patient tolerance of that canal under very wide distention, were being freely noised abroad. Bigelow had been in the habit of prolonging his sittings of ordinary lithotrity for from ten to fifteen minutes, and no harm had come from it, and the further lengthening of the sittings, the recognition of the value of prompt removal of the detritus, the adoption (practically) of the Otis standard of urethral calibre, and the construction of some large, thin-walled metal tubes with an ingenious suction apparatus at the distal end, made his operation, which only needed to be modified by experience to become perfect.

This operation is to-day accepted by Thompson, and is described in the last edition of his Lectures to the exclusion of old-fashioned lithotrity, which he apparently no longer performs. Indeed, the new operation promises in a few years to displace the old one entirely, and for the most part to do away also with lithotomy for males who have passed the age of puberty.

Irish surgeons have seemed inclined to ascribe the origin of the idea of litholapaxy to Sir Philip Crampton,[1] who at the opening of the Meath Hospital, in Dublin, showed an evacuating bottle (Fig. 1222) which he had devised for drawing away the urine from an atonied bladder in which lithotrity had been performed. The bottle was of glass. The air was exhausted from it and its stopcock turned. Then a Heurteloup's large-eyed steel catheter was introduced into the atonied bladder full of water and crushed stone,

Fig. 1222.



Sir Philip Crampton's evacuating bottle.

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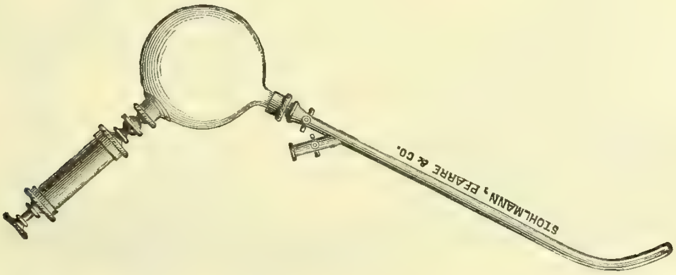
[1] Dublin Quarterly Journ. of Med. Science, vol. i. p. 1. 1846.

the bottle was attached, and the stopcock turned. The case of a Mr. Rodger, aged 70, is reported. His bladder was atonied. Heurteloup had previously operated upon him, but without entire success. Crampton relieved him by the aid of the evacuating bottle.

Bigelow was fully aware of Crampton's device, and refers to it in his paper, but Crampton did not for a moment contemplate the idea of litholapaxy. He simply adopted an expedient to lend power to atonied muscles, and to expel the contents of a bladder the walls of which were incapable of performing that function for themselves. Heurteloup, too, used a large-eyed steel catheter with jointed stylet, and doubtless often washed out the bladder through it, but he did not conceive the idea of litholapaxy. Various other inventors from time to time devised evacuating tubes, to which syringes, rubber balls, or evacuating pumps were attached.

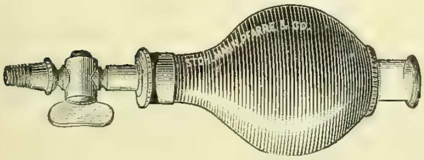
Among the most prominent names are those of Leroy d'Étiolles, Cornay, Mercier, Nélaton, Maisonneuve, Clover, and Coxeter. Cornay's *lithérétie* (Fig. 1223) was described in 1845, one year before Crampton's bottle, which it resembled in many respects, differing in that it combined the possibility of injecting the bladder through a double-current catheter with the principle of pneumatic aspiration. Mercier, in 1872,[1] published a description of a washing bottle (Fig. 1224) made of rubber, oval in shape, with a glass receiver for fragments below. It very closely resembles in principle, and, indeed, in appearance, some of the first washers used by Thompson and Bigelow, and was worked without valves by alternate compression and relaxation of the rubber-bulb filled with water, while the fragments collected below in the glass receiver. But Mercier did not dream of litholapaxy. He states distinctly[2] that he had devised his washer for use "quand la rétention devient

Fig. 1223.



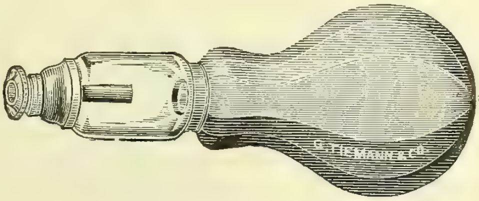
Cornay's lithérétie.

Fig. 1224.



Mercier's washing bottle.

Fig. 1225.



Clover's first evacuator.

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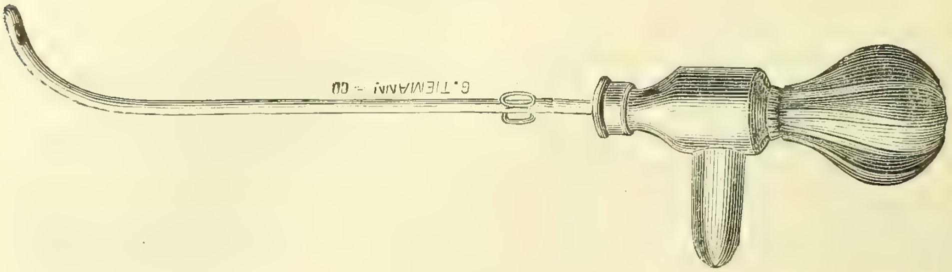
[1] Traitement préservatif et curatif des sédiments, etc. Paris, 1872.

[2] Op. cit., p. 370.

complète"—in other words, to help the bladder out when it should prove inadequate to the task of expelling the urine and the débris.

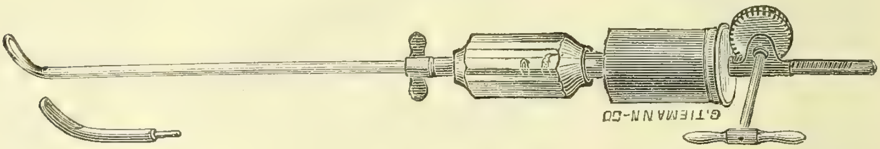
The English rubber suction-bottle, known as Clover's apparatus (Figs. 1225, 1226), having a glass receiver, and a metallic catheter with large eye, or open at the end, is one of the best models of the old type of instrument. With it Thompson did good work before better washers were provided. The same tube, with a metallic pump above the receiver, was known in France as Nélaton's evacuating apparatus (Fig. 1227).

Fig. 1226.



Clover's improved evacuator.

Fig. 1227.

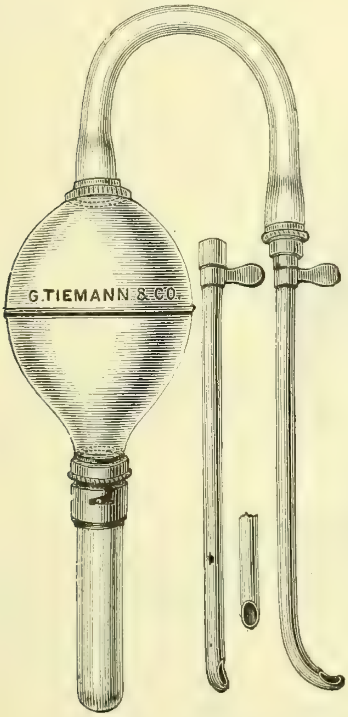


Nélaton's evacuating apparatus.

Bigelow's first evacuator had the demerit of admitting air into the tube, which greatly interfered with the proper function of the instrument. Many modifications and devices have since appeared. I shall give illustrations showing the changes, but shall only describe the instrument as perfected. It is entirely possible that before these words appear in print, new and important modifications may be made, though it is hard to imagine a washer that could work more perfectly than Bigelow's latest pattern. I have used all the varieties except Guyon's, and, thus far, prefer Bigelow's last model. Figs. 1228, 1229, 1230, and 1231, represent the Bigelow instruments, Fig. 1232 being the latest and best, the one he now advocates exclusively.

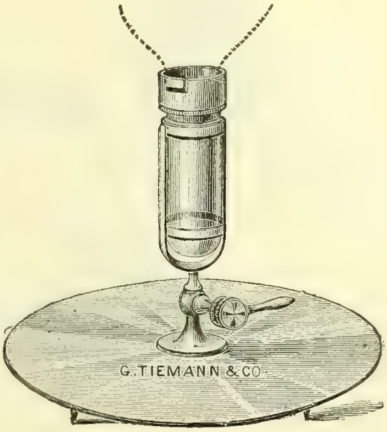
Bigelow's last evacuator (Fig. 1232) is an elastic rubber bulb, with a glass receiver and two stopcocks of metal. Within the bulb is the tube-strainer—a metallic tube, open at the end, and perforated with small holes crowded closely together over its entire surface. The bulb is worked by alternate compression and relaxation of the hand which grasps it. The fluid in the glass receiver is out of the way of the currents started by compressing the bulb. This is filled from above, and any air in it accumulates there out of reach of the aperture of the tube. The air may be easily discharged through the upper stopcock, and its place may be supplied by directly pouring water in or sucking it in through the coiled tube. The fragments of stone are drawn by suction through the evacuating catheter, the lower stopcock, and the open end of the tube. There are no valves, there is no stand, there is no rubber connecting-tube between the lower stopcock and the evacuating catheter. The rubber walls of the bulb are thick, and their elasticity and suction power great. The apparatus when coupled may be entirely freed from air-bubbles. The fragments are received at exactly the centre of the bulb and sink at once into the receiver. The return flow only moves the frag-

Fig. 1228.



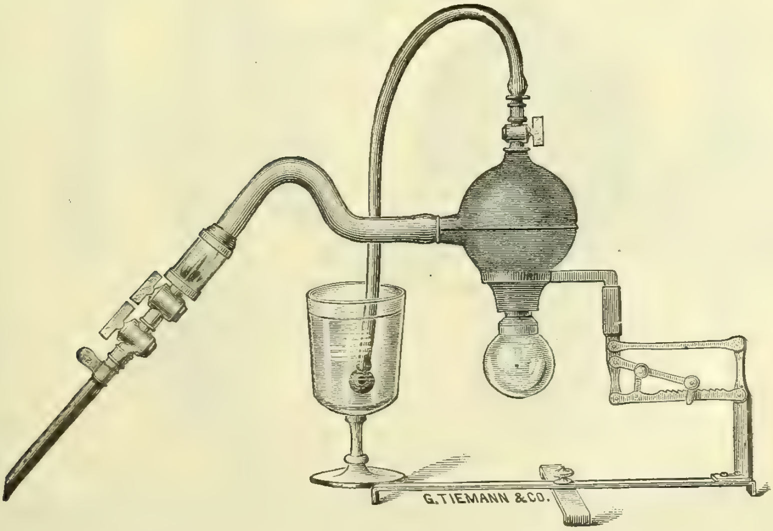
Bigelow's first evacuator.

Fig. 1229.



Stand for the evacuator.

Fig. 1230.

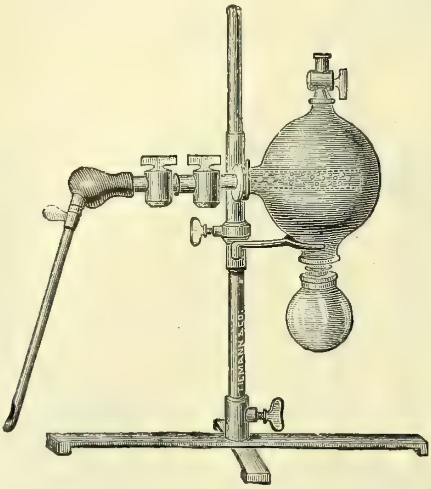


Bigelow's second evacuator.

ments which have last escaped from the tube-strainer and does not carry them to the bladder.

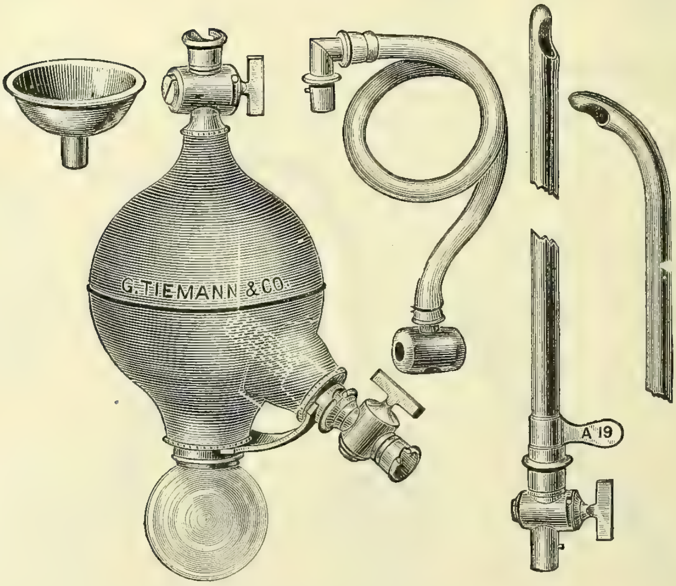
In the figure are certain accessaries of the apparatus not essential to its use. The rubber tube fits at its angular metallic tip upon the upper stopcock of the evacuator, while the weighted extremity rests in a basin or pitcher of hot water; during the use of the evacuator, by means of the combination, air is expelled from the bulb or water thrown out or sucked in at will, to vary the amount of fluid in the bladder during the washing, the whole manœuvre being promptly performed by turning the upper stopcock and compressing

Fig. 1231.



Bigelow's third evacuator.

Fig. 1232.

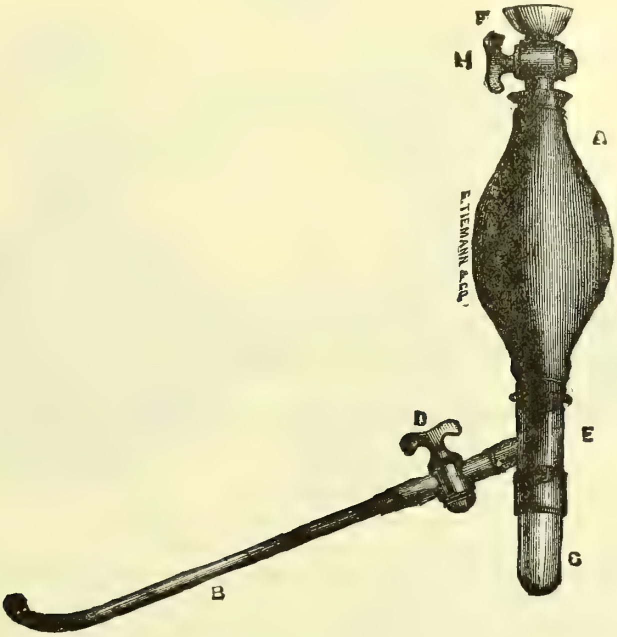


Bigelow's latest evacuator.

and relaxing the bulb. The metallic funnel is to substitute the tube in filling the evacuator through the upper stopcock.

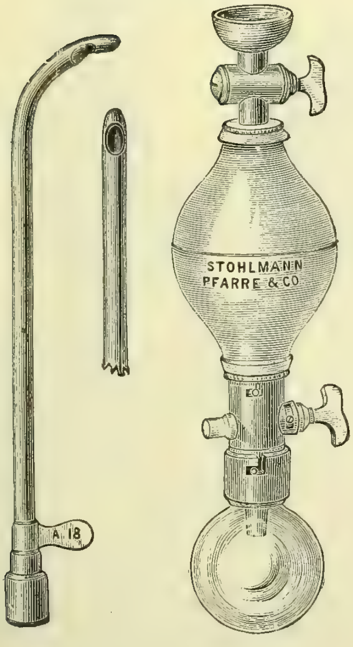
Operators who are familiar with the use of the tube seem to prefer it to

Fig. 1233.



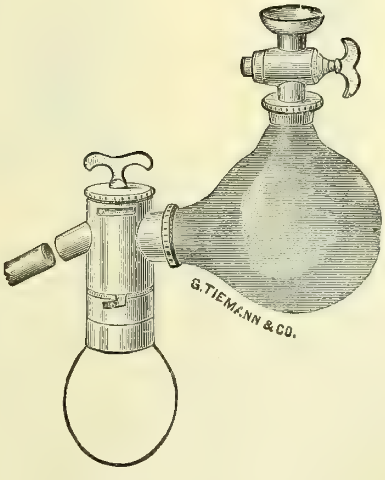
Thompson's first evacuator.

Fig. 1234.



Thompson's second evacuator.

Fig. 1235

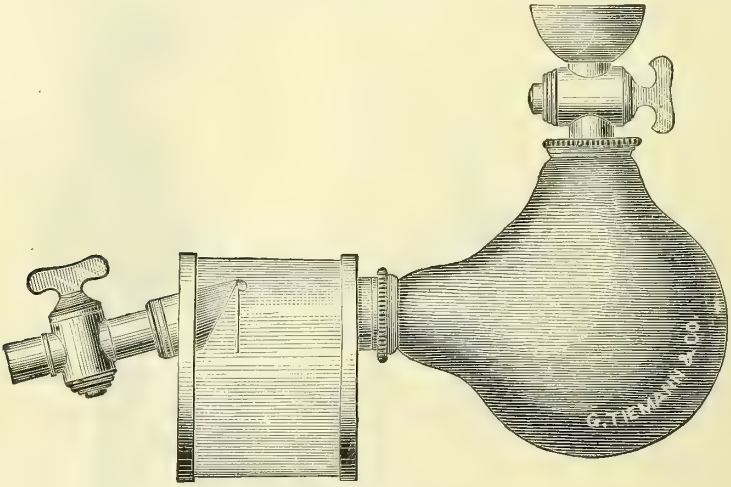


Thompson's third evacuator.

the funnel. The extra stopcock below is for use upon the evacuating tube before coupling, that air may not enter it.

Sir Henry Thompson's evacuator has also passed through four distinct stages. I represent them in the annexed figures, but only describe the latest.

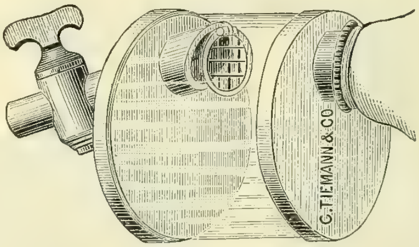
Fig. 1236.



Thompson's fourth and latest evacuator.

It is a rubber bulb, the central axis of suction of which is nearly in the line of the axis of the evacuating tube, but not as much so as in the case of Bigelow's instrument. The glass reservoir is situated in front of the rubber bulb, and a swinging, perforated valve hangs over the orifice of the tube, to prevent the return of fragments into the bladder.

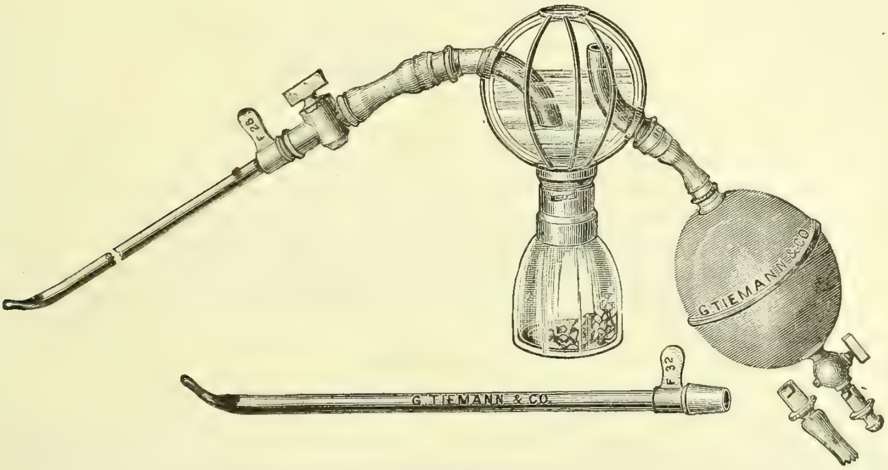
Fig. 1237.



Reservoir of Thompson's evacuator.

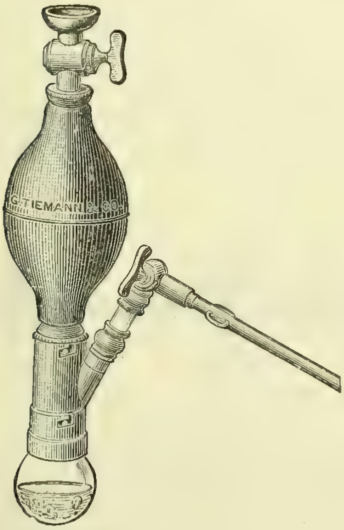
Other evacuators, such as those of Hill, and of Corradi of Florence, I do not think it necessary to reproduce. Otis's evacuator involves a new mechanism, and as it is the first of its pattern it should be allowed opportunity for modification before it is judged, because each of its chief rivals has received several modifications before being given to the world as perfect. The figure sufficiently describes it. The sphere through which the tubes show is of glass, as is also the receiving bottle. The tubes, stopcock, and couplings are of metal, the power a rubber ball. It works without valves and delivers effectively. It is filled through a tube and stopcock at the tail of the rubber bulb, and may be worked with this bulb full either of air or of water. My objection to this instrument is that it is impossible to get the air all out of the glass sphere by any method of filling, so that although no air is thrown back and forth into the bladder, yet the noise it occasions in the glass sphere prevents an accurate appreciation of the size of the fragments as they strike against the tube within the bladder. I find the instrument also less convenient in manipulation than the Bigelow bottle. It is a little cheaper than other instruments, and further modifications may bring it to that degree of mechanical perfection for which Dr. Otis's instruments are so justly celebrated.

Fig. 1238.



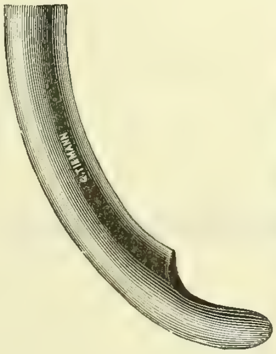
Otis's evacuator.

Fig. 1239.



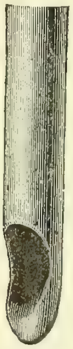
Guyon's evacuator.

Fig. 1240.



Curved evacuating tube.

Fig. 1241.



Straight evacuating tube.

Guyon's evacuator (Fig. 1239) should be referred to, since it has done so much good work. It does not commend itself as a mechanical triumph, but Guyon has proved that it is effective.

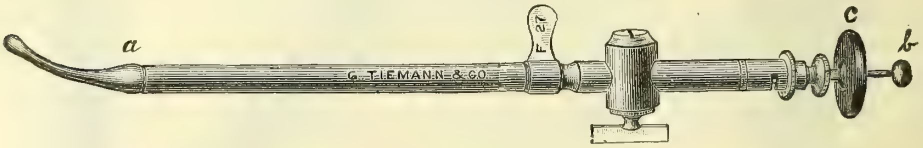
The evacuating tubes used in litholapaxy are curved and straight. Thompson and Guyon prefer the former, Bigelow the latter, but all lithotritists use either, as occasion requires. The tubes are made of thin metal, the eye so shaped as to scrape the urethra as little as possible on the way in or out, and, theoretically, not to catch fragments which are too large to pass the tube. The former end is attained very satisfactorily, the latter not so. I have not yet seen a tube with an eye which does not catch and hold fragments too large to pass the tube, and I have tried them all. Fig. 1240 shows the curved tube in profile. The straight tube (Fig. 1241) is identical as to its eye and its general construction with the curved tube.

These tubes are introduced as if they were curved or straight sounds, except that the straight tube may sometimes be twisted or rotated in through the fixed curve of the urethra where direct pushing will not succeed in making it pass. On account of the tendency of the eyes of all these tubes to catch fragments too large to pass through the tube itself, I have devised another form of straight tube, the eye of which cannot clog. When the eye of a tube does clog, if the fragment impacted in it is hard and angular, it may happen that water will not dislodge the fragment. No matter how forcibly the bulb is compressed, the fragment will stick in its place, and will be withdrawn with the tube, unless the operator is willing to uncouple the evacuator and push a solid stylet of some sort down to the extremity of the tube, while the end of the latter is still in the bladder. This manœuvre exposes the patient and his bed to a wetting, so that the surgeon is tempted to pull the tube out, charged as it is with a barb at its extremity.

I have seen the roof of the urethra quite sharply scratched on more than one occasion in this way. Once I saw a stone, so caught in a tube, drawn forward until it caught at the point of physiological narrowing of the pendulous urethra, in the third inch from the meatus. Here it stuck, and it was impossible to move the tube either way, or to dislodge the stone even with a solid stylet. Finally, by the exercise of very considerable force, the tube, still holding the stone, was dragged out—a manœuvre the reverse of surgical.

With the aim of averting any possible impaction of a fragment in the eye of the tube, I have used a straight tube of thin metal open at both ends (Fig. 1242). A wooden obturator makes its introduction reasonably easy, and a washer on the obturator allows the latter to be withdrawn without leakage beyond the stopcock, which, being turned, keeps the bed dry until the washing bottle has been fitted to the tube. Such a tube in some cases renders valuable service, particularly in evacuating a last fragment, or in washing out a small stone recently descended from the kidney. Anything which once enters cannot fail to pass, and anything which lodges in its vesical opening will be immediately dislodged as the fibres of the vesical neck close over the tube during its withdrawal. It delivers very promptly to the washing bottle, but has this defect, that in order to make it functionate to its best advantage its vesical end must be drawn close down to the neck of

Fig. 1242.



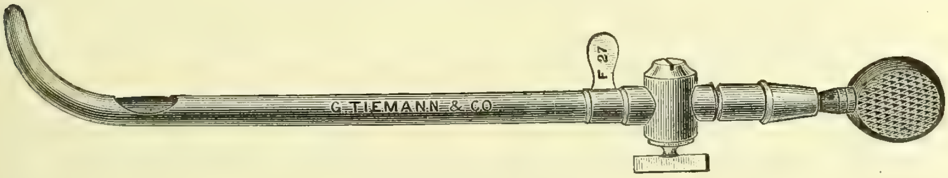
Keyes's evacuating tube, straight.

the bladder and held there. If it is pushed too far in, it does not return the wash properly, and the back wall of the bladder flaps inconveniently, perhaps painfully, against its open end, being drawn upon it by the suction of the evacuating bottle. On the other hand, if it is held close to the vesical neck the orifice of the tube may slip out into the prostatic sinus during the working of the bottle, and there bruise the membrane and fail to do its work. The tube therefore requires some care in its use, and for continuous work is not as valuable as those generally employed, but as an extra tube it has a function of its own, which I have found of value in shortening the operation.

Furthermore, in introducing the tube the operator must be quite certain that its tip has penetrated into the vesical cavity before he attaches the bottle, as otherwise, if he leaves the end of the tube in the prostatic sinus, he will wash in vain; I have known this accident to happen in able hands, and to produce a low opinion of this tube's value in the mind of the operator.

Finally, because a straight tube renders débris so much more readily than a curved one, I have had a curved tube made (Fig. 1243), with a large eye on its straight part, and a stopcock for protecting the bed from wetting while entering and withdrawing the obturator, which should always be used when the eye is very large, for fear of drawing out an impacted fragment. This tube is curved as far as introduction goes, but straight for all purposes of delivery. It works very well in my hands.

Fig. 1243.



Keyes's evacuating tube, curved.

Joseph H. Warren has devised a spiral revolving tip, for attachment to the end of curved and particularly of straight tubes, in order to facilitate their introduction. Experience at my hands does not justify the claims made for this addition to the instrument.

As to size, Bigelow advocates the use of the very largest tube that will pass. Undoubtedly, the larger the tube the more satisfactorily does it render the débris to the washing bottle. But most operators rather shrink from distending the urethra to its utmost capacity, and use only as large a tube as the urethra will admit comfortably, perhaps after incising a bridled meatus. This is a sound rule to go by, and one generally followed. The meatus, if constricted, or with a pocket at its lower commissure, should be incised rather freely, and then as large a tube should be used as will go easily past the point of physiological narrowing in the third inch of the pendulous urethra, and nothing larger. This physiological point of narrowing almost invariably exists, and should not be cut or even over-stretched to accommodate a tube.

Perfectly effective work is constantly being done through tubes of moderate size. Thompson rarely goes above 16 English—27 French—and has smaller tubes for those who require them. Guyon uses about the same size. I have performed the whole washing, in an old man whose urethra I was particularly desirous of sparing, with a No. 20 (French) curved tube. The tubes I employ run from 20 to 32 (French).

Mode of Performing Litholapaxy.—The patient having been prepared as already directed (page 216), is etherized and placed upon a table covered with a rubber cloth. The table should be high, narrow, and long. The patient lies upon his back, with the hips elevated a few inches above the table, the shoulders being low.

Two assistants are essential, one to administer the anæsthetic, the other to attend exclusively to emptying and refilling the washing bottle. It is well to have a third assistant to hand instruments, etc.

The first manœuvre is to introduce the curved tube selected for the operation, incising the meatus if necessary. Through this tube all the urine is drained away. Now the washing bottle, charged with a saturated solution of borax at 100° F., is attached to the tube. But the urine having trickled away in its last drops through the tube leaves the latter full of air, an element fatal to nicety of washing. This air may be disposed of most simply. The tube is withdrawn until its eye is in the prostatic sinus, the washing bottle is attached and the stopcock turned, but no further motion made. In an instant, the air contained in the curved tube is felt and heard ascending through the stopcock and mounting into the top of the rubber evacuator, where it does no harm, and whence it cannot possibly return into the bladder.

As soon as the rising bubbles of air have announced that the tube is full of water, the bulb is compressed, water distends the prostatic sinus and neck of the bladder, and the tube passes on almost unaided into the vesical cavity without damaging the neck of the organ. I have found this flushing manœuvre of great assistance in certain cases of enlargement of the prostatic third lobe. It is not necessary when a straight tube with obturator and stopcock is used, for in such a case the tube does not contain air. Now alternate contractions and relaxations of the rubber bulb are practised. This demonstrates the presence of the stone by the clicking noise made, while at the same time the wash disinfects the bladder. Two or three ounces of the fluid are left in the bladder, and the tube is withdrawn.

The next step is the crushing. This is done according to the rules already laid down for ordinary lithotrity. All the seizures should be made deliberately, it being remembered that a cardinal rule of rapid lithotrity is to work, if not slowly, at least with deliberation. No instrument should be used which can by any possibility clog. Seizures are made in prompt succession, no time being lost in clearing the blades. After a dozen or more successful seizures the lithotrite is withdrawn and the tube reinserted, with the precautions as regards the entrance of air already alluded to, and the washing commences.

The curved tube is first held so that its curve presses backwards and downwards upon the bladder behind the trigone. Then it is moved from side to side, and partly drawn out, finally inverted and held a little way up by depressing its distal end—the washing being kept up constantly as these changes in position are being made. The straight tube is held with its aperture as nearly as possible in the centre of the bladder, and preferably turned downwards; it also is rotated in different directions. The straight tube with an open end is so held that its opening lies just inside of the neck of the bladder.

The washing is performed by an easy succession of synchronous movements of the hand. When the fragments come into the receiver more slowly, and particularly to catch a last fragment, it is proper to compress the bulb rather violently, to maintain it compressed for an instant, and then suddenly to let up the pressure. When there is much angular débris the pieces rush together toward the eye of the evacuating tube, and, crowding into it, momentarily clog it, so that although they rattle most musically, there is very little show in the receiving bottle. In such a case much better rendering will be effected by a succession of sharp, jerky, partial contractions of the bottle, so as to dislodge the accumulating fragments about the eye of the tube, only to stir up one or two, and to allow these to be sucked into the receiver.

Occasionally an angular piece of stone will clog the eye of the tube, not large enough to prevent a reasonably free passage of fluid, but effectually blocking the way to any fragments larger than dust. Now again, the fragments rattle about the tube, but the washing gives no return. An experienced operator always recognizes this accident at once; an unobservant one may lose much time before he finds it out.

When this accident occurs, a sharp gush of water sent suddenly through the tube will sometimes dislodge the fragment. Sometimes it will fail. Then the water should be drawn off, the tube uncoupled, and a solid stylet passed to drive out the fragment into the bladder. This is safer than to withdraw the tube with the stone impacted in it, although the latter course is the one usually adopted, and, as a rule, no harm comes of the slight scratching of the urethra which it occasions.

Often, as the tube is moved from side to side, and particularly when the curved tube is inverted, the bladder-wall flaps with a sharp click against the eye of the tube, and then flutters spasmodically with dull thuds against the open end of the instrument. This suction of the bladder-wall into the eye of the instrument has never been known to do any harm, but it must bruise the organ somewhat, and its repetition should be avoided by shunning the particular manœuvre which occasions it. When the bladder is empty, the sharp click given by the wall as it is sucked against the eye of the tube is often so hard in quality as to resemble the sound given by a fragment of considerable size. An operator not accustomed to the sound may be deceived in this way, and may go on indefinitely searching for a fragment which does not exist. Error may be avoided by noticing that the click may be produced at will by turning the tube in a given direction. A little experience teaches the operator all that can be known about this fluttering of the bladder.

Should air enter the bladder, it churns up the water needlessly, distends the bladder, and interferes with the efficiency of the wash, while it so confuses the sounds that the click of small fragments against the tube can no longer be clearly distinguished. To dislodge the air, the bladder should be fully distended, and then the handle of the tube strongly depressed between the thighs, so that its eye may be raised to the top of the bladder. While held in this position the rubber bulb is worked slowly, and the air escapes into the bottle, and remaining at its top can be discharged through the upper stopcock.

After the fragments cease to collect in the receiver, the operator removes the tube, and hands the bottle and receiver to his assistant, who immediately pours out the water, more or less stained with blood, empties the fragments, and refills the bottle. While this is going on the operator has again introduced his lithotrite, made a dozen or more seizures, and by the time the bottle is ready there is usually enough débris to call for another wash. In this way, by alternate crushings and washings, the fragments are steadily reduced in size and extracted.

SEARCH FOR LAST FRAGMENT.—A last fragment is sought for by auscultation during the process of washing. Every bubble of air is scrupulously removed from the bladder, and with a small tube—the bladder containing a little surplus of water, so that when the exhausting bottle is full the organ shall not be entirely empty—it is gently washed while the operator places his ear directly over the lower part of the abdomen. The tube is turned in various positions and the operator listens. The swash of the water, as it rushes in and out, is heard with startling distinctness, and, if the management of the tube is skilful, any fragment of stone lying loose in the bladder is sure in a short time to be driven against the metallic tube and to announce its presence by a characteristic click, quite distinct from that emitted by the flapping of the bladder-wall against the eye of the instrument.

Fine sand and thin scale of stones make no sharp click, and all such may be left fo pass by nature's efforts; but any piece large enough to require the lithotrite can hardly escape detection by the educated ear.

After-treatment of Litholapaxy.—This is practically the same as already laid down for cases of ordinary lithotrity. No vesical washings are required unless retention comes on, or atony exists, or the urine has been highly offensive before the operation. In such cases borated washings comfort and purify the bladder.

The symptomatic treatment includes rest in bed, a hot-water rubber bottle for the hypogastrium—which is commonly the seat of pain—opium, quinine, sweet spirit of nitre, alkaline diluents, and mineral waters.

The sense of relief experienced after litholapaxy is often immediate and delightful. The patient exclaims at his comfort. Reaction may be very moderate, but it is not well to be too promptly reassured, since after a period of several days' calm, similar to what is noticed sometimes when an old case of vesical atony is for the first time relieved by the catheter, cystitis may set in and considerable distress be experienced. There may be retention of urine for the first twenty-four hours or more, or there may be none. There may be more or less urethral fever.

Generally, the urine ceases to be bloody from the second to the fourth day, and the patient may be up and about his room, or even out of doors, at the end of a week; but in any case, no matter how well he may feel, it is expedient to avoid risks and to keep him upon his back for about that period. He may arise to urinate, or to take a hot-bath—but should not sit up for any length of time. One of my patients, however, a gentleman of nearly seventy, after quite a severe operation, got up and took his cold sponge bath every morning without any evil result.

Time consumed by the Operation.—Bigelow operated continuously during upwards of three hours, removing seven hundred and forty-four grains, and his patient did perfectly well.[1] Thompson,[2] starting with a much shorter limit of time, now says that none of his calculi have required more than seventy minutes, this time having been required to remove a hard uric-acid calculus of which the débris weighed 1320 grains. The patient did well. Guyon's longest operation lasted seventy-five minutes. Reginald Harrison removed a two-and-a-half ounce stone in two hours and ten minutes,[3] and Coulson, in an article[4] reporting eleven cases with two deaths, says that his largest stone weighed 2060 grains, and was removed in three hours and a quarter. My longest operation lasted ninety-five minutes.

Therefore, it may be concluded that the element of time is not a very important factor in the operation, and while it is obviously better to terminate the sitting with reasonable promptness, the signal for stopping is the complete evacuation of the stone. Of course, any general circumstance which would cause a surgeon to halt in the midst of any other operation, would weigh with equal, but with no greater force, here.

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[1] Am. Journ. Med. Sci., January, 1878.

[2] Lectures on Diseases of the Urinary Organs, 6th ed., p. 82. 1882.

[3] Brit. Med. Journ., Aug. 10, 1882.

[4] Lancet, March 19, 1881, p. 453.

The amount of débris which may be removed in a given time varies greatly with circumstances. The average now is much higher than formerly, since operators have learned their power. The best recorded yield in washing was three ounces (dry weight) of small stones in twenty minutes—72 grains to the minute—a result obtained in Thomas Smith's celebrated case of multiple calculi. This result was obtained through a tube of size No. 27 (French). Bigelow's first set of cases yielded a little less than an average of three grains to the minute, while in a recent case[1] he removed successfully 1388 grains in one hour and fifty-five minutes, exactly 12 grains to the minute. Thompson's[2] first series yielded an average to the minute of 16½ grains when the stone was hard, 12½ when it was soft, while one of his later cases, that of the large stone already alluded to, gave him nearly 19 grains to the minute. My own first average[3] was only 4½ grains to the minute, while a recent case of hard phosphatic stone, 765 grains in 45 minutes, furnished me an average of 17 grains to the minute, and the patient did admirably, being up and dressed in five days. How much better may be done, time must determine, but no operator who values the safety of his patient should rank speed in the operation as highly as care and skill.

Relapse after Litholapaxy.—Relapse may occur after litholapaxy, as it does after lithotomy, a totally new stone formation taking place, but it cannot well occur otherwise if the precaution be taken to search the bladder carefully with a small tube and washing-bottle, after the patient has been up and about at his duties for a month or more. This manœuvre is so necessary that it might almost be termed the last step in the operation.

One thing only in the way of relapse cannot be guarded against by litholapaxy, or indeed by any operation, and that is *phosphatic re-accumulation*. In cases of chronic cystitis with atony, where the patient will not take intelligent care of his bladder, and in cases of encysted stone, or chronic pyelitis, and the like, phosphatic re-accumulation must and does occur.

Intelligence on the part of the patient may be required in these cases, and acuteness on the part of the surgeon to detect the cause of the phosphatic re-accumulation, and to do away with that cause if possible. But even in those cases in which the cause cannot be removed, the comfort furnished to the patient by litholapaxy, without risk to life, is far greater than could be afforded either by simple lithotrity or by lithotomy.

Often when the cause of the phosphatic re-accumulation is chronic vesical catarrh, kept up by enlarged prostate and muscular atony, relapse after litholapaxy may be prevented by scrupulous attention to vesical irrigation, and by occasional injections of dilute nitric acid, of a strength varying from a few minims up to a fluidrachm, in a pint of warm water.

Complications during the Operation.—These are injury to the urethra, injury to the bladder, hemorrhage, clogging of the lithotrite, breakage of a lithotrite, inability to introduce the tube, clogging of the tube.

The *urethra* is not likely to be injured by a lithotrite unless the instrument is withdrawn with its jaws impacted, or still containing a hard, jagged fragment. The *bladder* may very easily be injured to a varying extent by pinching up a fold of mucous membrane, with more or less of the muscular coat of the bladder, or even tearing it away in the grasp of the instrument. The resulting injuries are ecchymosis, contusions, excoriations, and lacerations of varying severity.

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[1] Boston Med. and Surg. Journ., Dec. 29, 1881, p. 612.

[2] Lancet, Jan. 10, 1880, p. 44.

[3] Loc. cit., p. 14.

It is possible with any lithotrite to pick up a fold of the bladder, pinch it slightly, and then let it go. I have done this on the cadaver and on the living subject with equal ease with the instruments of Bigelow, Thompson, and myself. With the old-fashioned fenestrated lithotrite, having a cutting edge upon the male blade, this accident was fraught with danger; with modern instruments, managed with a little care, the accident is unimportant. In many cases it is impossible to perform litholapaxy without having the water, even of the first wash, distinctly tinged, sometimes positively darkened, with blood. This blood comes from the slight scratching injuries inflicted upon the mucous membrane of the bladder, and upon its neck, by the jaws of the lithotrite and the angular fragments of the stone. Such a moderate appearance of blood is a matter of course, and in no way compromises the success of the operation, or portends an outbreak of serious inflammation at its termination.

Hutchison, of Brooklyn, using a lithotrite of one of my earlier and imperfect models, reported that he pinched off shreds of mucous membrane from the bladder, but no reaction followed, and "the result was satisfactory." Wynkoop, of New York, using one of the earlier Bigelow instruments, found the jaws to clog, and had to use much force in extracting the blades. The clogging appears to have been due to some mechanical defect in the construction of the instrument; abscess ensued from laceration of the deep urethra, and the patient was subsequently cut for removal of the remains of the stone and for cure of the abscess, and recovered. In another case treated by the same operator, in which also Bigelow's lithotrite was used, the patient died twenty-nine hours afterwards, and at the autopsy a number of abrasions and minute lacerations of the mucous membrane of the bladder were found. Hence, it may be assumed that a certain amount of scratching damage to the bladder is commonly produced by all lithotrites, but that, as a rule, such moderate damage does no harm. It need hardly be added that the less damage done, the better, and that, other things being equal, the better the operator, and the more perfect the instrument, the less will be the physical injury inflicted upon the bladder. On two occasions in former years I have, while practising the old operation, pinched off small shreds of mucous membrane from the bladder—once, in fishing for a soft catheter in a paralyzed bladder, the patient denying any sensation when the thin film of mucous membrane was seized, and once in working rapidly with an instrument which it was believed would not clog and could not catch the bladder. In neither of these cases did the least reactionary disturbance hinder the recovery of the patient, or indicate that any unusual damage had been done.

In a case where a suit for malpractice was instituted in New Hampshire, one of the lawyers informed me that an irregular practitioner had passed the lithotrite but had found no stone. After considerable search, another surgeon who was present introduced his finger into the rectum, and there found the jaws of the lithotrite which had passed through the membranous urethra. The wound healed, and the patient recovered.

My personal experience[1] has led me to conclude that damage done to the urethra by a clogged instrument, or by the use of tubes too large for the canal, is more likely to be followed by disastrous results to the patient than similar or even greater damage inflicted upon the bladder. Much damage can be done to the urethra as well as to the bladder without serious consequences, as will be shown when speaking of the clogging in lithotrites and impaction in tubes. In any case, it is only just to the patient upon whom litholapaxy is performed to use a lithotrite which will not clog, to operate with all possible care, to employ tubes which do not stretch the canal too decidedly, and to dislodge impacted fragments before withdrawing the tube.

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[1] Am. Journ. Med. Sci., April, 1880.

Hemorrhage during litholapaxy commonly occurs to a moderate degree, but the final wash, usually, is hardly, if at all, bloody. In some cases, on the other hand, the hemorrhage is profuse from the very first introduction of the lithotrite. I have had a case in which, on introducing the tube, pure blood flowed out, and only stopped after coagulation within the tube had made a plug large enough to occlude it. This plug was drawn out as a complete, long cast of the tube. The bleeding did not continue uniformly at this rate, and the washing was successfully followed up, but the amount of blood lost made it necessary to arrest the sitting before all the débris had been removed. Ten days subsequently the remaining two drachms of fragments were successfully removed, the remarkable fact being that on this occasion the amount of hemorrhage during the operation was exceptionally small. The patient was 75 years old; the stone weighed 513 grains; recovery was prompt and complete.

In a case of hemorrhagic diathesis, or if the bladder happened to contain a villous growth along with the stone, very serious hemorrhage might occur. I am not aware that any case thus far has been reported in which a fatal result after litholapaxy has been ascribed to hemorrhage. Ultzmann, however, has expressed the fear that serious, even fatal, hemorrhage may result from the operation.[1]

Clogging and Breakage of the Lithotrite.—The lithotrites commonly in use at the date of introduction of litholapaxy were of two kinds, both dangerous. The fenestrated lithotrite had a cutting edge along both sides of the male blade, and the male blade fitted snugly into the fenestra of the female blade. With this instrument, if the bladder was seized at all, a piece was quite certain to be cut out. The bladder could not be pinched and dropped, and consequently the fenestrated instrument was used only on rare occasions and with special care, when a very hard, large stone had to be fragmented into large segments preparatory to final pulverization.

The danger of using the instrument freely was well known, and was expressed by Thompson before the Royal Medical and Chirurgical Society of London, March 16, 1878, when he said that he had not used a fenestrated instrument in the bladder for ten years.

The non-fenestrated, pulverizing lithotrite would not readily catch the bladder or harm it much, if it did pinch up a fold; but it had its own especial danger in that it was quite sure to clog with débris after a few seizures had been made, and that it was generally next to impossible to free the blades when once they had become firmly impacted at the heel of the jaws. Consequently it was taught that, after from three to six successful seizures, the instrument must be removed and its jaws disgorged, to avoid inflicting serious damage upon the urethra.

In fact, at the meeting of the Royal Medical and Chirurgical Society, already alluded to, both Thompson and Coulson laid great stress on this impaction as sometimes "preventing the withdrawal of the instrument," and as having required, "in one case, incision in the perineum."

With such instruments, manifestly, litholapaxy could not be properly performed. But since the introduction of the new operation a number of lithotrites have appeared whose claims consist in three elements: (1) strength; (2) blunted roughness and lateral bevelling of the male blade, so that the bladder, if caught, need not be seriously damaged; (3) fenestration, with a large spur at the heel of the male blade, and comparative breadth of the female blade, to insure against impaction.

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[1] Centralblatt f. Chirurgie, No. 24, S. 393. 1882.

I have already recorded the impaction of a Reliquet instrument in my hands while performing old-fashioned lithotrity. In litholapaxy this accident has not occurred to me, and with the instruments which I now use, it is impossible.

Coulson, at the meeting of the International Medical Congress, in London, stated that on two occasions a lithotrite had broken in his hands. One of these cases was reported in the Lancet.[1] The instrument was a Bigelow lithotrite, defectively made. The collar holding on the male blade came off. The jaws had to be freed from débris by percussion, after which the lithotrite was withdrawn, no harm being done, and the operation was concluded with a fenestrated lithotrite.

Several cases of slight clogging of some of the earlier Bigelow instruments, due to defects in structure, have been reported (Wynkoop, Stein).[2] One of my lithotrites, of Tiemann's make, in the hands of Dr. Rockwell, of Brooklyn, broke at the heel of the male blade upon a large oxalate-of-lime stone which was too hard to be crushed. The patient was cut at once successfully. I was present at an operation at the hands of Dr. Weir, when a Bigelow lithotrite broke at the collar under exactly similar circumstances. The patient was then cut, and successfully relieved of a large oxalate-of-lime stone.

Alan P. Smith[3] reports a case of serious clogging of a lithotrite in the bladder of an old man. The instrument was of the Civiale model, made by Robert and Collin. After it had clogged, no efforts made at the handle could free the jaws, and consequently the instrument was forcibly extracted, when it was found that the jaws were separated to the extent of three-fourths of an inch; yet no evil result followed in this case.

Agnew,[4] of Philadelphia, refers to one instance in his knowledge, where a lithotrite could not be closed on account of some defect in the button which regulated the screw. As a consequence of withdrawing it with the blades apart, injuries ensued which proved fatal.

Should an instrument clog badly, it seems to me that it would be proper to cut the patient at once by the median section upon the lithotrite, dilate the neck of the bladder, and bring out the jaws of the lithotrite in the wound of the perineum, where they might be cleared. Such a course would be devoid of any considerable danger. If the jaw of a lithotrite should break within the bladder, it might be extracted by using a smaller lithotrite, or the knife might be resorted to with propriety.

COMPLICATIONS OCCURRING AFTER LITHOLAPAXY.—After litholapaxy, the same complications may arise as have been already set down as possible after lithotrity (urinary fever, retention, hemorrhage, cystitis, epididymitis—or even surgical kidney, possibly pyæmia, septicæmia, etc.—graver complications which will be considered under the head of complications of lithotomy). There is not, however, as much likelihood of complication after litholapaxy as after lithotrity, because the former operation is devoid of one great source of danger, namely, that arising from the repeated injuries inflicted upon the bladder by the sharp fragments left behind between the sittings.

The slighter complications are not uncommon (urinary fever, mild cystitis, epididymitis); the others very rare. The complications most to be dreaded are pyelitis and surgical kidney, due to already diseased kidneys, and failing vitality in an old patient, when the risks of an operation have been assumed rather than the prolonged endurance of the certain torture and slow death which would have followed had no operation been performed. I have not seen atony of the bladder follow litholapaxy, nor heard of it.

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[1] Lancet, Nov. 27, 1880, p. 853.

[2] Keyes, Am. Journ. Med. Sci., April, 1880.

[3] Maryland Medical Journal, January 2, 1882.

[4] Op cit., vol. ii. p. 661.

Thompson[1] speaks also of chronic cystitis with phosphatic deposits as coming on in some cases as an after-complication of litholapaxy, when it did not exist before the operation. The same complication has arisen in in his hands after lithotomy. He says further, that "one of the most persistent examples of phosphatic cystitis" which he has seen of late years followed an operation of rapid lithotrity done two years before, in which he removed with great ease in six minutes a small uric-acid calculus weighing 84 grains. He refers also to five other cases in which there was more or less chronic cystitis prolonged for a period of several months, in all of which "the calculus was uric acid, and cystitis was not present before the operation."

When this complication occurs, it is to be met according to the general principles governing the conduct of a case of chronic cystitis with tendency to phosphatic accumulation.

Applicability of Litholapaxy to Women and Children, and for the Removal of Substances other than Urinary Deposits.—The applicability of litholapaxy to children has already been considered (page 211). Females of all ages are admirably suited for the operation. I have employed it at both extremes of life.

Generally, the known existence of any substance in the bladder other than a urinary concretion, has been looked upon as a bar to the crushing operation, but with strong instruments and large tubes, certain exceptions must now be made. Pieces of bone, wood, wax, lead-pencil, slate-pencil, pipe-stem, or catheter, known to be acting as nuclei of stone, may be disregarded, crushed up, and washed away with the rest of the débris. I was present at an operation at the New York Hospital, in which Dr. Peters removed with some phosphatic débris quite a large piece of wax. Bigelow, in his first set of cases, removed a portion of catheter which was the nucleus of a stone. I have done the same. Holt C. Wilson[2] has quite recently reported a case in which he removed successfully by litholapaxy, from a patient of 42, a phosphatic stone and six inches of an English web-catheter, of size No. 8 (No. 15 French).

Lithotomy.

Lithotomy, like so many of the surgical terms which have been consecrated by usage, is a misnomer. We no longer cut the stone, as history tells us was done by Ammonius, but we cut the soft parts, more or less, and extract the stone whole, or after it has been broken.

The first known attempts at extracting stone from the bladder of the male seem to have been made long before the Christian era by the Hindoos. Doubtless, the idea first suggested itself to some one who witnessed the spontaneous expulsion of a calculus through the perineum, or perhaps liberated a large stone from a perineal fistula by a stroke of the knife. Certain it is, that the operation known as "cutting on the gripe"—the *apparatus minor*, as it was afterwards called on account of the small number of instruments required for its execution; also christened the method of Celsus, on account of the accurate description which that writer gave of the operation in the first century of our era—was the earliest ever performed, and that in spite of its rudeness and manifest imperfections, this, more or less modified, was the prevailing method of extracting stones from the bladder during twenty centuries.

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[1] Op. cit., 6th ed., p. 94.

[2] Med. Record, Dec. 23, 1882, p. 709.

The description of the Indian method of cutting on the gripe is essentially the same as that of Celsus. The latter only advises the operation for children between the ages of nine and fourteen ; afterwards it was used for patients of all ages, but it was recognized that the older the patient the more uncertain was the closure of the wound. Albucasis formulates this conclusion, and says that under fourteen years healing is easy.

The rude manœuvre of cutting on the gripe consisted essentially of three steps. First, some effort was made to cause the stone to fall toward the neck of the bladder by striking the shoulders, shaking the patient, and pressing upon or stroking the abdomen which had been previously greased. The second step was to hook the stone down by putting one or two fingers into the anus, and assisting the descent by the pressure of the hand of an assistant upon the hypogastrium. Meantime, the patient was held firmly by the arms and legs upon the lap of a strong assistant (or two of them, sometimes with one more at each side to steady the group), leaning back upon his breast. An incision was now made, generally with a broad knife cutting at both edges near the point, upon the stone as it bulged in the perineum. This incision, as described by Celsus, was usually curved transversely above the anus, each horn of the incision looking outwards and backwards. But incisions of other shapes were also made transversely, curving upwards, and on either side, until finally it came to be the proper thing to make the incision upon the left of the raphe, curving outwards, the convexity of the incision looking towards the anus. Velpeau ascribes to Antyllus the left lateral incision.

The third manœuvre was the extraction of the stone. Sometimes it was forced out by the pressure of the fingers behind it, but more often it had to be extracted with hooks, forceps, and the like, or cut with some special instrument to facilitate its removal—as practised by Ammonius. Various means of washing out the bladder and cleaning it of any remaining débris were afterwards introduced.

This operation must have counted many successes, for it continued to thrive, passing through the hands of travelling specialists to find champions for its defence long after its more surgical rival, the Marian operation, had appeared upon the field. The neck of the bladder was probably not often cut into at all by most of the surgeons who cut upon the gripe, although it was the aim of the deep incision, as recommended by Celsus, to cut across the neck of the bladder transversely. The bladder-wall itself and the back part of the prostate were incised by most operators, and the seminal vesicle and ducts of the left side were very constantly cut through.

There grew to be a prejudice against cutting into or across the middle line of the integument, or approaching the rectum—a prejudice which continued active after the introduction of the grooved staff by Marianus—on the ground that if the raphe were cut it would not heal, by reason of the callosity of the tissues there, and that fistula would be quite certain to follow ; and that if the hemorrhoidal vessels near the anus were opened, very dangerous or fatal bleeding would result.

The *apparatus major*, the conception of which has been ascribed to the Italian surgeons Battista da Rapallo and Joannes de Romanis, was first publicly described by the pupil of the last-named surgeon, Marianus Sanctus, in 1524. Whereas almost no instruments had been required for the older operation, this one was burdened down by machinery. The essential advance made by this operation, from a surgical standpoint, was the introduction of the *itinerarium*—the guide to the neck of the bladder—the grooved staff upon which the incision was to be made.

Marianus did not, however, cut into the neck of the bladder. He counseled strongly against it, asserting that a division of the constricting muscles of the bladder would be unavoidably followed by incontinence of urine. The operation was essentially an incision in the left side of the perineum upon a grooved staff; by some operators it was made upon the extreme right. The urethra was opened to the breadth of the nail of the thumb, and the parts beyond were dilated and torn rudely with rough instruments. Sometimes the stone was broken before extraction. Joannes de Romanis advocated this modification, but Marianus objected to it. Extraction was effected by forceps and scoop.

Ottavien da Villa, a pupil of Marianus, came to France and communicated his method to the surgeon Laurent Colot, and Henry II., in 1556, created for the latter the position of Court Lithotomist. The Colot family retained the secret, and practised lithotomy as specialists for more than a hundred years, and it is related that in the seventeenth century the secret was stolen from Jerome Colot (who died in 1684), by some ambitious surgeons who bored through the ceiling of the operating room at La Charité, in order to watch the great operator at his work. They were not a little surprised and disgusted to find that the operation so long kept secret, was only a slight modification of the apparatus major of Marianus, which was every-where known.

Thus it appears that the apparatus major was essentially urethrotomy with dilatation of the neck of the bladder and extraction of the stone, often after it had been broken, an operation which in our own day has been slightly modified, but much improved, as the perineal lithotrity of Dolbeau.

After the adoption in the apparatus major of the staff, or *itinerarium*, all sorts of variations in the incision, external and internal, began to appear. Franco sustained the prejudices of his time, and feared to cut the raphe. His mind was actively occupied with devising better means for penetrating the bladder. He even suggested the use of a double cutting instrument resembling the double lithotome, which was then in use for enlarging wounds. With this he proposed to incise transversely the neck of the bladder, although there is no evidence to show that he ever actually did it. To Franco is ascribed remotely the origin of the lateral operation, somewhere near the middle of the sixteenth century, although to Frère Jacques undoubtedly the distinction more properly belongs. Franco, however, certainly did discover the *supra-pubic* operation, and described it quite graphically in 1561.

He was at that time cutting habitually in the perineum, when it happened to him to be called upon to extract a stone as large as a hen's egg from an infant two years old. He cut in the perineum and vainly tugged at the monster stone, but was unable to get it out, and then, actuated by the solicitations of the parents and friends, who wished their child to die rather than suffer longer—and driven to it, as he himself confessed, by a false pride, lest he should be reproached with having been unable to get the stone away—he cut the child over the pubes, and the infant recovered.

Attempts to fix the origin of the supra-pubic operation at a date earlier than this have failed, and historians now generally agree in giving Franco the credit of the origination of the operation in 1560.

In 1581, Rosset first described a regular operative method of reaching the bladder by cutting above the pubis, but he never practised it; and although occasional cases are recorded, or alluded to (Piètre, Colot), and although there was considerable discussion about the operation, it was not until Frère Côme, with his "sonde à dard" and other accessories (12 in all, which he considered essential to the proper performance of the task), had operated a number of times between 1758 and 1779, that the operation took veritable shape. Frère Côme's operation has been the one commonly employed up to a late date.

Much discussion relative to the high operation occurred among surgeons in the early part of the present century, and more favor came gradually to be accorded to it. Cheselden performed it, before finally adopting his perfected lateral operation. Souberllielle became its champion in 1840. Vidal (de Cassis), in 1852, made a modification by doing the operation in two sittings, to avoid infiltration. Valette, in 1858, attempted to operate by cauterization; Chassaignac, and afterwards Tisseire, tried the écraseur. Baudon made a special study of suturing the vesical walls. Petersen, in Germany, Poland, in England, Guyon, Monod, and Périer, in France, and Dulles, in this country, have of late years been its warm advocates. Van Goudoever, in a communication made to the Medical Congress at Amsterdam, in 1879, made a strong plea for the operation in the case of infants, and Petersen,[1] of Kiel, by the introduction of the rectal colpeurynter, as one of the steps of the operation, and Guyon,[2] of Paris, by further modifications, have given a still stronger impetus toward a resuscitation at home and abroad of the old operation of Franco.

It has not yet been made clear, however, by statistics or otherwise, that the operation is a good one for any cases except those of adult men with very large or encysted stones, or with vesical tumors of large size, and for the extraction of certain foreign bodies. If it is a good operation for general adoption in all cases that are to be cut, the point has not yet been proved. Dulles, its chief advocate in America, has not, as far as I can learn, recorded any operation of his own. His advocacy seems to be based upon reasoning. E. Bouley, in a monograph of 260 pages (Paris, 1883), gives an excellent historical sketch of the operation.

The *lateral operation* dates its definite existence to Jacques Baulot, commonly known as Frère Jacques, the greatest of all the itinerant lithotomists. He was born in 1651, and entered the army as a common soldier at the age of sixteen. Here he encountered a travelling lithotomist named Pauloni, and followed him for about six years, assisting him in his operations. Then Jacques set up for himself and had a most notable career. He adopted a monastic garb in order to distinguish himself and gain more power over the people, but he never made any pretensions to being a monk, although he accepted the appellation "Frère." He went to Paris in 1697, being at that time 46 years old, and possessed of considerable reputation in the provinces. His instruments were simple—a large staff without groove, a long pointed bistoury, a dilating conductor, and a heavy pair of rough forceps. His early work in Paris was varying in its success, until finally, in 1698, he was selected to do the spring operating at the Charité Hospital. He cut 60 patients: 23 died, 24 remained in the hospital with incontinence, fistula, or other serious disorders, while only 13 recovered. The ordinary death-rate in that day was about 1 in 7, by the common operation as practised by surgeons generally, and therefore Jacques, covered with confusion, yielded to the public condemnation and left Paris. He now, when 48 years old, began to dissect and to study under Fagon, at Versailles, and made such good progress, adopting the grooved sound, etc., that in 1701, at Versailles, he cut 38 patients consecutively, and with success in each instance. In 1702, he published his method in pamphlet form, and in 1704 was lauded on all sides, loaded with testimonials, and fêted in every quarter; portraits were made of him, medals were struck off, gold sounds were given to him, and various other demonstrations were made of his wide-spread popularity. He died in 1714.[3]

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[1] Langenbeck's Archiv, S. 572. 1880.

[2] Ann. des Mal. des Organes Génito-Urinaires, Déc. 1882, p. 1, et Janv. 1883, p. 97.

[3] These details, and many other facts in connection with the history of lithotomy, are taken from Chauvel's masterly article, "Cystotomie," in the Dictionnaire Encyclopédique des Sciences Médicales.

Rau, in Holland, operated very successfully. In 1713 he said that he had cut 1547 patients. He operated by what is believed to be have been the lateral method, but no exact record of it has been left. He said in his lectures to his pupils, "Since I am obliged to live and gain my sustenance mainly by the employment of this method, I will not describe it to you at all. If I were forced to tell you something about it, that which I would tell you would not be the truth, wherefore I prefer to maintain absolute silence. If you can learn my method by seeing me operate, I have no objections to make, but, for the rest, read Celsus."

At about this time, early in the eighteenth century, Cheselden began to remove stones from the bladder by the supra-pubic operation. Until this time most of the English lithotomies had been according to the apparatus major of Marianus Sanctus. Cheselden, having heard of the success of Frère Jacques, tried the perineal operation, but promptly lost four out of ten patients. This stimulated him to new efforts. He studied the subject profoundly, and finally reached the perfected lateral operation, performing it in all its essentials as it is done to-day. His fame spread abroad to such an extent that, in 1729, the French surgeon Morand was sent by the French Académie des Sciences, at the expense of that institution, to study the method of the distinguished Englishman in London.

No notable modification of the lateral operation has been made since the days of Cheselden. A vast number of minor innovations have sprung up, but nothing fundamental. The main trouble has been to get uniformity of opinion as to the extent of the internal incision, and in order to make this a matter of mathematics two instruments have appeared in the field, the cutting gorget and the concealed lithotome; the former cutting from without inwards, a distance regulated by its breadth, and the latter cutting from within outwards, to a depth regulated beforehand by the distance to which the point of the concealed knife is allowed to protrude from its sheath.

The first *cutting gorget* was one of the instruments of the apparatus major. Its edge was sometimes sharpened that it might cut the prostate, but blunt instruments were generally used to effect dilatation of the vesical orifice. Presently innumerable gorgets, blunt and sharp, single and double, of various curves and shapes, were devised, each operator seeming to have his favorite. These have nearly all become obsolete except the blunt gorget, which Thompson still recommends to be used as a guide for the forceps in the case of a deep perineum, in fat men with large prostates.

The *lithotome caché* was given to the profession through the columns of the Journal of Verduin, in 1748, by its inventor, Jean Baseilhac, better known as Frère Côme. This instrument is still in general use in France. It has been abundantly modified, but not as extensively as the gorget. Dupuytren's double lithotome caché, with which he performed his bilateral operation, is perhaps the best known of the modifications.

In the line of the cutting gorgets and lithotomes belong the triangular blade of Civiale, to be pushed along the groove of the conductor, and the broad probe-pointed knife of the late N. R. Smith, of Baltimore. Cosaccio, in 1847, devised a deep gutter to replace the groove of the sound, in which gutter the point of the cystotome could glide, but from which it could not escape. Numerous similar sliding cystotomes have been devised since that date. One very well known in New York, is the bisector of the late James R. Wood.

Most English and American surgeons use the scalpel or the Blizzard knife with which to incise the neck of the bladder, preferring it to any cystotome, lithotome, or gorget.

The *bilateral operation* is only a modification of the lateral; the original operation of Celsus was bilateral, the external incision being transverse, with the curved ends of the incision looking backward, while the aim of the internal incision was to divide the neck of the bladder transversely. Chaussier and Béclard both had the idea of a double lithotome, and the latter in 1813 had such an instrument constructed, but he did not use it upon the living subject, and to Dupuytren, in 1824, belongs the credit of having formulated and executed the bilateral operation as it exists to-day.

The *median operation* dates back into the age of the apparatus major, where operations were done on one or other side of the raphe (para-rapheal). The deeper incisions have been variously modified, as in Civiale's medio-bilateral method, but the median operation as practised to-day was first performed early in the present century by Manzoni, of Verona; afterwards by Borsa and Rizzoli, also in Italy; and more lately still by Allarton, in England. Markoe has been active in his efforts to introduce it in this country. It has achieved a distinct position among the recognized operations of lithotomy.

The *medio-lateral* (Raynaud, 1824) and *medio-bilateral* (Civiale, 1828) were special operations which have not created for themselves any fixed position, while the quadrilateral cystotomy of Vidal (de Cassis), 1828, has fallen into entire and well-merited oblivion. The same may be said of the attempt to perform lithotomy with the thermo-cautery, introduced not long since by Mallez, and employed several times by him. Verneuil and Anger both tried it for the superficial incisions, and in this country, on one occasion, L. A. Stimson. The manœuvre has no merit to recommend it, and many disadvantages.

Recto-vesical lithotomy remains to be considered. This is an operation which no longer finds a place in most text-books, yet its claims deserve notice in a historical way. In 1817, Sanson proposed two operations through the rectum; one above the prostate, through the trigone; the other through the body of the prostate and neck of the bladder. The operation in either case is easy. The lower fibres of the rectum are cut in the middle line, upon a sound previously passed, and having a central groove. Then the bas-fond is perforated, or the urethra just in front of the apex of the prostate, and a central incision is made along the groove of the sound, through the prostate in one case, one inch backward through the trigone in the other. A large stone may be readily extracted by this method, but difficulties in the way of closing the wound result. The operation has been nowhere received with general favor. One of its strongest defenders was Vacca Berlinghieri, in Italy, who divided a portion of the perineum as well as the rectal wall. Death or permanent rectal fistula has been found to be so constant a sequel of the recto-vesical operation, that it has, at the present day, few if any advocates. Section of the ejaculatory duct is a matter of necessity in the prostatic variety of this operation. The substitution of the écraseur for the knife did not enhance its value.

Sims proposed direct section of the bladder behind the prostate, and immediate application of metallic stitches. Schaeffer formulated rules for the performance of the operation and for subsequent suture, using the latter both for the method involving the prostate and for that interesting the trigone. He employed thread coated with rubber, instead of silver. No efforts have succeeded in establishing rectal lithotomy as a justifiable operation. Its statistics are worse than those of the high operation, with the additional disadvantage that, among those who recover, a certain proportion retain permanent fistulous communications between the rectum and the bladder or the urethra. A recent effort has been made by Bauer, of St. Louis, to advance this operation into general favor by detailing a case of recto-vesical lithotomy in which he used silver sutures. The case did not do very well. Bauer refers[1] to a former operation done by himself, in 1859, and to the *trigonum section*, described in 1881 as a new operation by Muehlhäuser, of Speier. Gross[2] refers to a case in which Bauer extracted a stone and got a good result by the use of five wire sutures, but gives no reference. He also says that Noyes, in 1860, made a central prostatic incision, enlarged it bilaterally within, and got a good result with metallic sutures.

Maisonneuve proposed a form of rectal lithotomy in which the membranous urethra was opened through the rectum, and the prostate and neck of the bladder approached with a double lithotome through the rectal wound. It has found no favor. Malgaigne attempted it four times. He lost two patients, one retained a recto-urethral fistula, and only one recovered.

General Considerations concerning Lithotomy.—The history of lithotomy shows that all efforts to reach the bladder by the knife have been made through regions containing parts the wounding of which was not considered mortal. The track leads always through the perineum, over the pubic symphysis below the peritoneum, through the rectum (or the vagina in the female), attacking the organ where the peritoneum does not cover it. The rectal operations have been condemned by general consent. The vaginal operation is in full favor for women.

For the male there remain two sets of operations, the one approaching the bladder through the perineum, the other above the pubis. .

Of the perineal operations there are in reality but two, the lateral and the median. The other methods are only modifications, the bilateral and prerectal forms of external incision, the bilateral division of the prostate. Such special methods as those of Buchanan, Key, Smith, Wood, and others, are only varieties of detail in executing a method—not special methods. The median external incision receives modifications (medio-lateral, medio-bilateral) according to the incisions made in the prostate. Again it is modified in what is known as perineal lithotrity.

The high operation is always made nearly in the same way, the variations being largely as to the opening in the bladder and the question of sewing it up.

Selection of a Method in Lithotomy.—In considering the question of lithotomy relatively to a given stone, it is proper to ask what operation should be selected. In former days, and even now, an operator often selects a favorite method and submits all the patients whom he cuts to it. This is manifestly unjust; unfair to the method, unfair to the patient. All operations have something in their favor, none of them are without the reproach of having defects under certain circumstances, and, although undoubtedly an operator grows more and more familiar with an operation which he has often performed, and does it better than he would another, yet it is manifestly his duty to familiarize himself reasonably with all operations, so that his resources during an emergency may be ample.

Now, a stone is small, medium-sized, or large. Thompson's dictum is generally accepted on this subject. A medium-sized stone is one which averages not more than an inch each in two of its diameters. Thus a stone two inches long or longer might appropriately be styled a medium-sized stone, as far as the practicability of its removal by the cutting operation was concerned, if its two broad diameters averaged about an inch each.

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[1] St. Louis Med. and Surg. Journ., 1870; and Archiv f. klin. Chir., Bd. xxvii., S. 180. 1881.

[2] System of Surgery, 6th ed., vol. ii. p. 758.

Anything beneath this medium size is a small stone, and anything above it is a large stone.

The very careful dilatations of the prostate and neck of the bladder made experimentally by Dolbeau with his ingenious dilator, have shown that the neck of the bladder cannot be distended to a diameter greater than 20–24 millimetres without the production of organic lesions of the prostate and vesical neck. These lesions are single and large, or multiple and small, radiate lacerations, extending more or less deeply. Dolbeau's experiments I have repeatedly verified upon the cadaver. Twenty-four millimetres is just short of one inch; therefore manifestly no stone an inch in diameter, more particularly when surrounded by the blades of the forceps, can pass the neck of the adult bladder without determining physical lesions by laceration. I have seen a stone nearly two inches in diameter dragged through the uncut vesical neck in the median operation, by a surgeon who was obliged to use all his force in order to extract it. The patient recovered, but the exhibition was the reverse of surgical.

Lacerations of the neck of the bladder are not necessarily fatal, as proved by nearly all the earlier applications of the apparatus major, in which branched dilators were used with the express object of tearing the neck of the bladder, under the impression that the parts so torn would heal better than if they had been incised. It was not until the beginning of the eighteenth century that the advantage of cutting over tearing the neck of the bladder was recognized (Schaeffer, 1704; Rosa, 1714).

Modern surgeons entertain little or no doubt that incisions through the neck of the bladder are less harmful than the bruising, lacerating violence of sudden dilatation, whether effected by dilators from without or by violence from within, in efforts to extract the stone. Hence it may be logically concluded that, for any stone an inch in diameter, or thereabouts, the neck of the bladder should be cut, and that the median operation, pure and simple, is not properly applicable under such circumstances, while either the mediolateral, the bilateral, or the lateral operation, would be entirely appropriate.

But the median operation has a logical place. It is anatomically accurate, in that it cuts no important structure in the middle line if the bulb be spared, and that it avoids the chance of much hemorrhage. The wound generally heals promptly. The neck of the bladder, if not too much overstretched, regains its tonicity almost at once, and the patient, soon after being cut, controls his urinary evacuations nearly as well as before the operation. He is, therefore, if matters progress favorably, soon up and out, giving to the method a charm and brilliancy, both in execution and result, which are not at all as striking in any other method.

But if the stone is one inch in diameter, the patient will probably do but little less promptly well, and more safely, if to the external median incision there is added a slight incision into the neck of the bladder on one or both sides.

Therefore the median operation is most suited to small stones; but it has been shown by experience that such stones are most properly dealt with by litholapaxy, unless for some other reason it is desirable to perform cystotomy. This other reason is most commonly the presence of intense chronic cystitis, and a desire to furnish the bladder with entire rest by thorough drainage for some days. Such drainage is best effected by lateral lithotomy, for the reason that it overpowers the sphincter, but the bladder may also be drained by a large tube kept in through a central perineal wound. The latter method indeed is preferred by some operators for drainage when the choice is open, and when stone does not enter into the question of cystotomy at all, as in Sir Henry

Thompson's method of vesical exploration with the finger through a central perineal opening.

The lateral operation plainly allows a larger external opening than the median, and the internal opening by a double incision may be made as large as possible without encroaching upon the body of the bladder; therefore this operation, the lateral, logically belongs to stones over an inch in diameter, and up to such a size as the operator may feel himself justified in attacking through the perineum. Very large stones, of four, five, or even seven ounces, have been removed unbroken through the perineum, and the patients have recovered; but, as Mr. Crosse, of Norwich, has shown, the larger the stone the greater is the mortality. A stone two inches in diameter may be taken through a prostate which has been incised bilaterally—for each incision counts for three-quarters of an inch, and the natural dilatability of the urethra for another inch—but when a stone larger than this is taken out, the body of the bladder must participate in the incision, or be torn into to allow the passage.

This cutting into or tearing the body of the bladder is by no means as formidable a complication as might be supposed. In making a number of experimental incisions, and extracting smooth stones of various sizes from the cadaver, I have been surprised to see how often the body of the bladder is both cut into and lacerated when the stone to be extracted is of considerable size. Cutting into the body of the bladder was rather the rule than the exception in the apparatus minor, and it was the design and object of the operator in some of the earlier manœuvres. Again, in the child the prostate is rudimentary, the incision being made cleanly through it and into the body of the bladder beyond, yet the well-known success of lateral lithotomy with children more than justifies the procedure. Although, however, a large stone may come out safely through the perineal incision—and the more safely the younger the individual—yet, especially in old people, in view of the statistical mortality, it is not prudent to cut far, nor to use any rude force in extraction, and a large stone should be broken and extracted in fragments rather than as an uninjured trophy. The great opportunity for drainage offered by lateral cystotomy in cases of severe chronic cystitis, is a strong argument in favor of this method.

When a stone is very large—over two inches in diameter—supra-pubic lithotomy is to be preferred. The well-known mortality attending the extraction of very large stones need not again be discussed, but it is just here that the high operation has obtained some of its most brilliant triumphs. Often it has occurred that the operator, going in by the perineum, finds the stone too large to extract. He then, perhaps, attempts to break it, and fails. Finally, he opens the bladder above the pubic symphysis, takes out the stone, and recovery crowns his efforts.

Tumors have several times been removed by this same double manœuvre, and it is fair to raise the question whether the success of the high operation in these cases has not been more due to the thorough drainage of the bladder furnished by the free lateral incision than to any other cause; and whether, in a contemplated case of the high operation, it would not be good surgery, as a preliminary step, to perform either lateral cystotomy or the median operation with a large tube tied in for drainage, rather than to incur the danger of infiltration and inflammatory disturbances incident to the unnatural and undrained outlet furnished to the urine in the roof of the bladder. The Guyon-Périer method of drainage lately adopted in France may, perhaps, answer as well. If this method of reasoning be accurate, it follows, if any lithotomy is to be employed, that (1) for small stones, when the bladder is not inflamed, the median operation is appropriate; (2) for small stones, when the bladder is inflamed, unless the operator proposes to tie in a tube through the perineum, the lateral operation should be chosen; (3) for stones at and over one inch in diameter, the lateral operation is suitable, up to stones of one and a half, and even occasionally two inches, the bilateral prostatic and even the bilateral external incision being made in such cases; (4) for stones at and above one and three-quarters inches in diameter, it is safer, after opening the perineum, to fragment the stone before extraction, this being more imperative in the case of elderly men, and (5) for very large stones, the supra-pubic operation is suitable.

Prostatic Incision.—There is more uncertainty about the internal incision in lithotomy than about any other feature of the section. Great varieties in incision into the prostate have been advocated, that which leads backward and outward in the direction of the greatest diameter of the lateral lobe of the gland having received most general approval. The respective merits of cutting and dilating have also been long and ardently discussed. Mathematical calculations have been entered upon with great precision to estimate the length of the prostatic incision on each side, and the consequent size of a stone which may be delivered through the opening without passing the limits of the prostate. This formal computation cannot be justified by a calm consideration of the facts. In the first place, the size of the prostate varies greatly at different periods of life. The measurements given conscientiously by equally good authorities vary for the same period of life. Thus the oblique radius in the adult has been made to vary all the way from ten to twenty-five millimetres.

Then, again, the prostate is not a cylindrical body, but terminates in a thick, rather abrupt, posterior border, while anteriorly it comes to a thin, blunted point. Now the stone must come out through a cylindrical channel, and the consequence is that, in the case of any stone of large size, the fibrous sheath of the prostate is necessarily cut through or torn through toward the apex of the gland, and very often posteriorly as well, while the body of the bladder is often involved.

Laceration of the soft parts about the neck of the bladder takes place in a radiate direction, following the line of a previous incision. The soft tissues also stretch considerably, but to a varying extent, in different subjects. Hence, the practical conclusion can be but one, that the incision through the neck of the bladder and the prostate should start in the direction of the greatest diameter of the gland; and that if the stone prove too large to be taken out through such an incision made with reasonable freedom, then a liberating incision must be made on the other side; and that if the stone will not even then come through after the application of moderate force, fragmentation should be resorted to, or even the high operation.

If it be decided to make the double prostatic incision, this can perhaps be most accurately done with the double-cutting lithotome caché. But frequently it turns out that the operator only determines to make his second cut after he finds that his first is inadequate. He does not usually reach this conclusion until some instruments have been passed, and the wound has been more or less dilated. Moreover, the natural elasticity of the tissues causes some displacement of the customary relations of the parts; and if, added to this, it is remembered that the second, liberating, lateral incision is made upon the finger as a guide, sometimes with the stone in the bite of the forceps more or less distending the already cut vesical orifice, it can be appreciated that this incision will not fall exactly where it is the intention of the operator to place it unless special care be used.

In experimenting upon the cadaver I have been surprised to find how easy it is to make the second incision in the wrong place. It is even possible, after having made the usual lateral incision and distended the vesical neck, to cut upon the finger in the usual direction—outwards and slightly backwards upon the right side of the prostate—and to find upon dissection that the incision has commenced near the middle line, and perhaps severed the seminal ducts. Therefore, it is wiser in making the second incision to direct it more laterally than obliquely outwards and backwards, and in this way, if the parts have been distorted by previous distention, the line of the incision will fall about where it belongs. The incisions have been made designedly in this direction, obliquely outwards and backwards on one side and transversely on the other, by Senn, who has made a profound study of the dimensions of the prostate relatively to the question of lithotomy.

The only modern novelty in the direction of the internal incision for lithotomy has been proposed by Furneaux Jordan[1]—an incision directly upwards; but it has nothing to recommend it.

OPERATIONS THROUGH THE PERINEUM.—The operations in the perineum which call for a separate description are the lateral and the bilateral, with their modifications, the median, medio-lateral, medio-bilateral, and the perineal lithotrity of Dolbeau. The rectal operations are almost as obsolete as the apparatus major and apparatus minor.

Preparations for all Perineal Operations.—These are the general preparations already advised (page 216). All previous examinations as to the condition of the kidneys, the size and position of the stone, its composition, the number of stones, and the possibility of encapsulation, must have been attended to. Obstacles, such as contracted pelvis, hernia, etc., must be noted. Hydrocele should be tapped. If stricture is present, its size and calibre must be determined, and the plan of its management decided upon. The condition of the bladder as to inflammation, and the size of the prostate, are factors in the computation. The rectum must be thoroughly cleared by an enema a few hours before the operation. Quinine, morphine, jaborandi, and diuretic mineral waters are useful here as preparatory means, just as they are in the preparations for lithotrity. The perineum should be shaved. Five assistants are required: one for the ether, one to steady each knee, one to hold the staff—the position of honor—and a fifth to hand the instruments and do any other work that may be needed.

The table should be about thirty inches wide and very solid, furnished with a pillow and an old blanket covered with a rubber cloth. Its lower end should face a window. Beneath it are placed an old carpet or rug, and a broad basin containing sawdust, bran, or an old wet towel, so that the blood and urine dropping into it may not spatter. The operator selects such a chair or low stool as shall place the reclining body of his patient upon the table, a little lower than his chair as he sits upright. At the operator's right, within easy reach, stands a small table covered with all the instruments which can possibly be needed, the pot of vaseline for lubrication, the ligatures, and everything except the sponges. It is better to employ some fixed form of retentive apparatus than to trust to the unaided hands of assistants, be they never so skilful. The old-fashioned figure-of-eight bandage has given place to other forms of band, more solid, less liable to get out of order, and easier of adjustment. There are two varieties now in use: the bar, and the anklets and wristlets. The bar is a stiff iron cylinder with a solid extension-piece inside (Fig. 1244), by means of which it may be considerably lengthened, throwing the knees widely apart. At the ends of the bar are broad straps which hold the leg on either side just below the knee. A broad leather band completes the apparatus. This passes over the front of the shoulder on either side, and behind the patient's neck. By this contrivance the patient is held compactly together, and it is possible to operate with fewer assistants; but the bar is sometimes in the way, if an instrument has to be passed through the urethra during the operation, and if the patient takes ether badly, the freedom of his hands is an objection.

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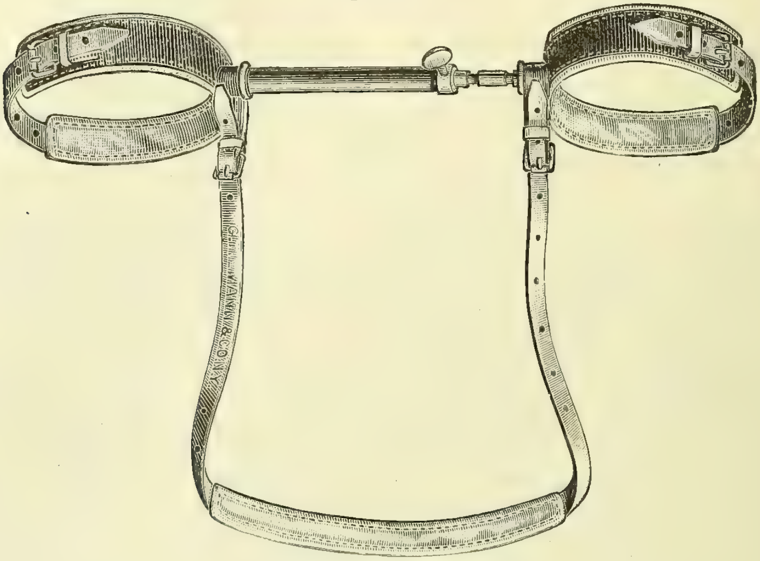
[1] Brit. Med. Journ., Jan. 24, 1880.

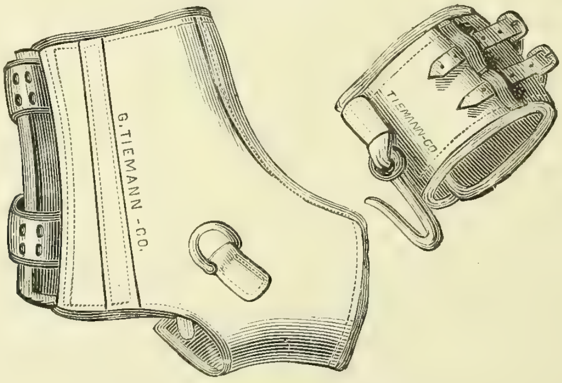
Fig. 1244.


G. TIEMANN & CO. N.Y.

Bar for separating limbs in lithotomy.

Of anklets and wristlets there are several varieties. Prichard's anklets and wristlets (Fig. 1245), are made of stout leather padded. The wristlet is furnished with a strong hook, and on either side of each anklet is a ring of metal. The pieces are put on separately and hooked up after anæsthesia is complete.

Fig. 1245.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TIEMANN-CO.

Anklet and wristlet for lithotomy.

Another variety has a padded ring to slip over each foot, and, attached to the outer side of the ring, a leather strap which is to be buckled about the wrist. Another has for the anklet a flat arrangement of padded leather, with the buckles in front and a hole for the heel behind, so as to allow greater ease of adjustment. Another, Reliquet's, has two iron bracelets, one for the wrist and one for the ankle, the latter with a retentive piece which passes under the foot. They are strapped on and hooked as usual.

All preparations being made, the patient is etherized in bed, and then carried to the table. The anklets and wristlets are next put on separately. Then the grooved staff is inserted. Tillaux relates that in one case operated upon by Civiale and Nélaton, these distinguished surgeons, having first bound their patient, had to release the bands before they could introduce the staff. The anklets are hooked to the wristlets, and the patient is drawn down to the foot of the table, the sacrum resting upon it, with the back flat, and the nates very slightly projecting beyond its end.

The assistants then steady the patient, holding the pelvis perfectly square, with the thighs equally flexed and abducted. The operator convinces himself that the end of the staff is in contact with the stone, and requests the chief assistant to verify the fact. If the stone cannot be struck by the staff in position, it is better to defer the operation. Except in cases of known encystment, the staff can always be made to touch the stone, unless the latter be quite small and lying in a bas-fond behind the prostate. In such a case, a finger in the rectum will raise the stone and make it strike the staff. The possibility of there being a false passage which the staff may enter, makes this precautionary verification of its contact with the stone imperative.

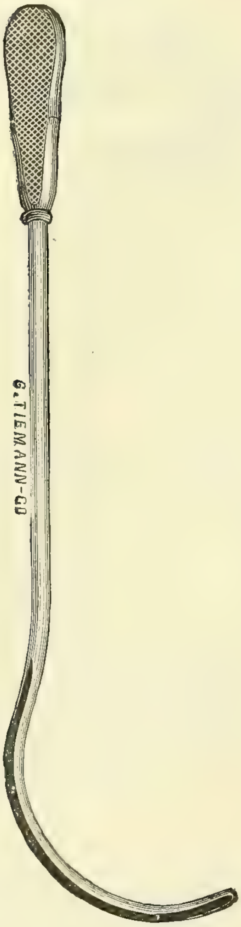
The chief assistant holds the handle of the staff vertically upwards from the body, sometimes slightly inclined toward the patient's head, and bulging in the perineum if the operator so desires it. His thumb presses flatly against the rough side of the handle, three fingers embrace the penis in front, and the little finger passes behind the dorsum of the member. With his left hand he draws up the scrotum, maintaining the line of the raphe exactly in a central position. With the hands so placed, the curve of the sound is to be held firmly hooked up under the symphysis. The flat side of the handle of the staff must be constantly held transversely to the long axis of the patient's body. The chief assistant must allow nothing to divert his attention; no curiosity in leaning forward to watch the cut must disturb him, and at nothing less than the command of the operator may he alter this relation of affairs until the knife has entered the groove of the staff and fairly incised the urethra.

The operator now examines the rectum, and satisfies himself that it is empty, and that the curve of the sound passes the prostate. He touches the descending pubic rami, and presses centrally through the perineum upon the sound, mapping out mentally the outlet of the pelvis and the anatomical relations of the soft parts in the perineum. Having calmly taken in the situation and thought over his plan, the operator is ready, and the patient is in position for any operation upon the perineum.

I. Lateral Lithotomy.—The instruments required for lateral lithotomy are a steel staff of relatively large size—at least 21 (French) for an adult—and for a child in proportion. The handle should be coarsely roughened on the side that looks toward the beak, so that the thumb of the first assistant placed against it may run no risk of slipping or allowing the instrument to turn. The old-fashioned long curve is generally preferred (Fig. 1246), the curve starting backward from the shaft and bulging slightly behind its long axis. The groove should be rather broad and deep upon the right side of the staff, winding about it as a portion of a long spiral, and should end abruptly near the tip.

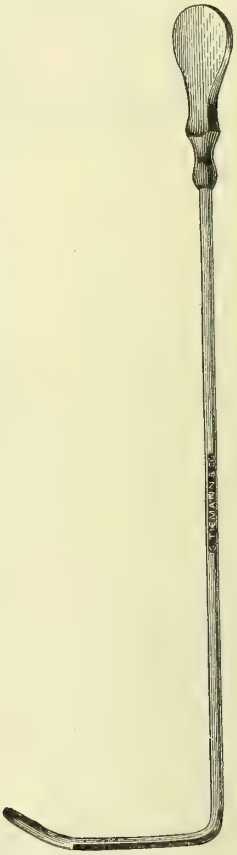
A modified rectangular staff (Fig. 1247) is preferred by some operators on account of the ease with which the groove may be struck, starting as it does at the angle of the instrument. The operation known by the name of Buchanan, of Glasgow, and favorably thought of in England, is performed with a rectangular staff inserted well into the bladder until the angle of the staff lies in the membranous urethra just in front of the apex of the prostate.

Fig. 1246.



Staff for lithotomy.

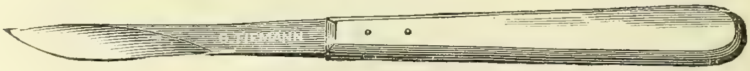
Fig. 1247.



Rectangular staff for lithotomy.

The perineum is transfixed with a sharp-pointed bistoury, the groove of the staff struck at the angle, and the knife carried directly onward into the bladder. The result is a cut like that of the lateral operation with both internal and external incisions of moderate size.

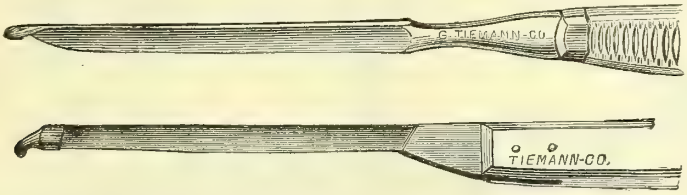
Fig. 1248.



Lithotomy scalpel.

It is well to have among the lithotomy instruments an ordinary searcher, with which to explore the bladder through the wound for fragments or multiple calculi. The scalpel generally used (Fig. 1248) is moderately bellied, seven or eight inches long, with a solid, straight back, a stout shank, and a blade about three inches long having a cutting edge of about an inch and a quarter. Some operators use the scalpel for the deep as well as for the superficial incision; but a straight, probe-pointed bistoury with a stiff back is often preferred, or the Blizard knife (Fig. 1249). The English model (Fig. 1250) of the same instrument has a more pronounced probe-point. Other forms of scalpel and bistoury, and cutting gorgets, are still sometimes used. The *lithotome caché* has few advocates in this country, but in France it is still popular.

Fig. 1249. Fig. 1250.



Blizard's probe-pointed lithotomy knife.

An American device, modelled after the well-known instrument of Sir James Earle,[1] is that of the late Professor N. R. Smith, of Baltimore,[2] and its claim has been championed by his son A. P. Smith, who has used it with brilliant success. Dr. A. P. Smith had operated 69 times at the latest report,[3] with two deaths, 63 times with the instrument in question (Fig. 1251). It consists of a rectangular staff, with a knife hinged upon the shaft in such a way that it cannot fail to strike the groove. The staff is introduced, and the hinged knife is made to penetrate the urethra. Upon a groove at the back of this knife the probe-end of a broad cutting gorget, shaped like a wide scalpel, is pushed along. It cannot fail to enter the groove of the staff, and on reaching the latter the end of the gorget drops into a cup-shaped cavity in the end of a watch spring which is so arranged as to travel smoothly along the groove. The gorget, pushed steadily onwards until the end of the groove is reached, makes a cut of definite breadth in the direction of the incision of lateral lithotomy.

Among the numerous varieties of forceps used to extract stone there are two types, straight and curved. Forceps should have thin blades, slightly spoon-shaped, so as to embrace the stone and not add materially to its bulk. The extremities of the spoons should not touch when the instrument is closed, so as to avoid pinching the bladder. The inside of the spoons is rough, to prevent slipping. They are fairly broad, so that the rough stone may not project much beyond them, and their curve is rather long from before backwards, so as to throw as much of a wedge-shape as possible into the jaws when charged. The handles are usually crossed, to allow a maximum distention of the jaws with a minimum dilatation of the wound. One of the handles is always a ring for the thumb; the other is sometimes left open to allow the hand to fit upon the instrument and exercise grasping power and traction more effectively.

It is well to have at least two sizes of the straight shape. Curved forceps

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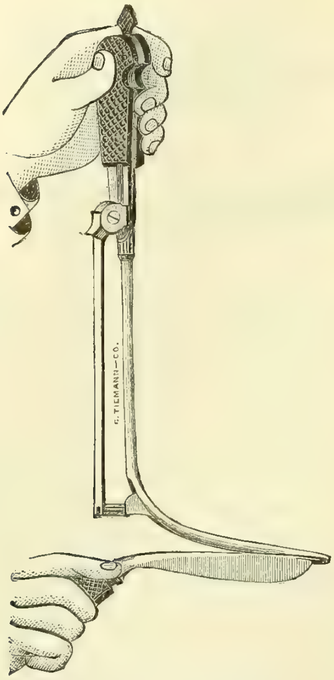
[1] Practical Observations on the Operation for Stone, 2d edit., with Appendix. London, 1803.

[2] Medical and Surgical Memoirs, by Nathan Smith, M.D., edited with Addenda by Nathan R. Smith, M.D. Baltimore, 1831. A similar instrument has also been employed by Dr. Corbet, of Glasgow. (Med. Times and Gazette, Dec. 16, 1858.)

[3] Gross, System of Surgery, 6th ed., vol. ii. p. 754.

Fig. 1251.



N. R. Smith's staff and knife for lithotomy.

Fig. 1252.

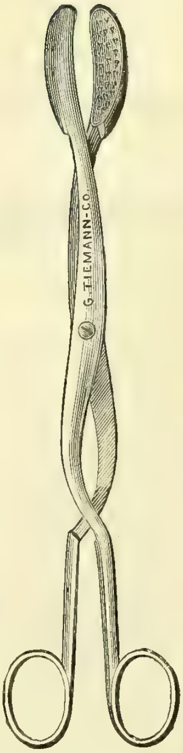
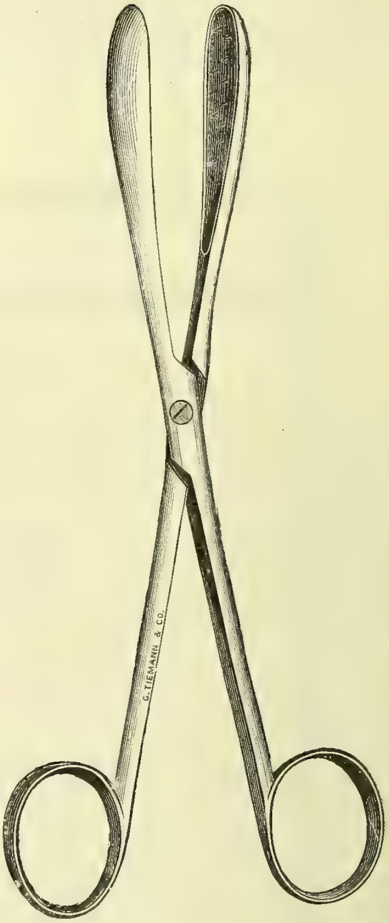


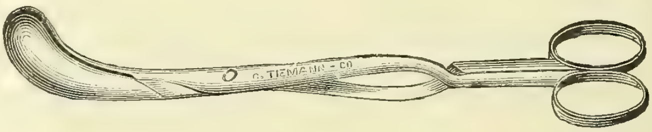
Fig. 1253.



Lithotomy forceps, straight.

are used for grasping a small stone behind a large prostate, or for getting at it if it is lodged above, behind the pubis. (Fig. 1254.)

Fig. 1254.

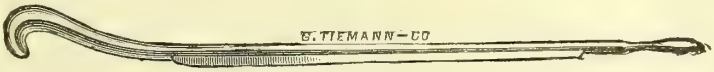


Lithotomy forceps, curved.

The crested scoop (Fig. 1255) is of great value. The scoop end removes débris. The probe-pointed extremity, fitted into the groove of the staff or following the roof of the urethra, enters the bladder without fail, and the crest serves as a certain guide to the forceps, whose closed jaws are yet sufficiently separated to receive the crest between them.

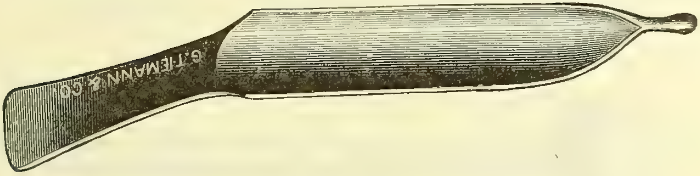
A blunt gorget having one straight and one curved margin (Fig. 1256), is recommended by Thompson, in case the perineum is so deep in a large fat man, and the prostate so long, that the finger cannot enter the neck of the bladder. The straight side of this gorget is entered along the staff, and upon it as a guide the forceps pass into the bladder.

Fig. 1255.



Crested scoop.

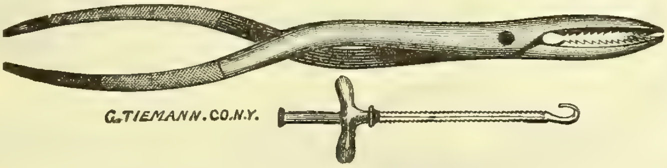
Fig. 1256.



Blunt gorget.

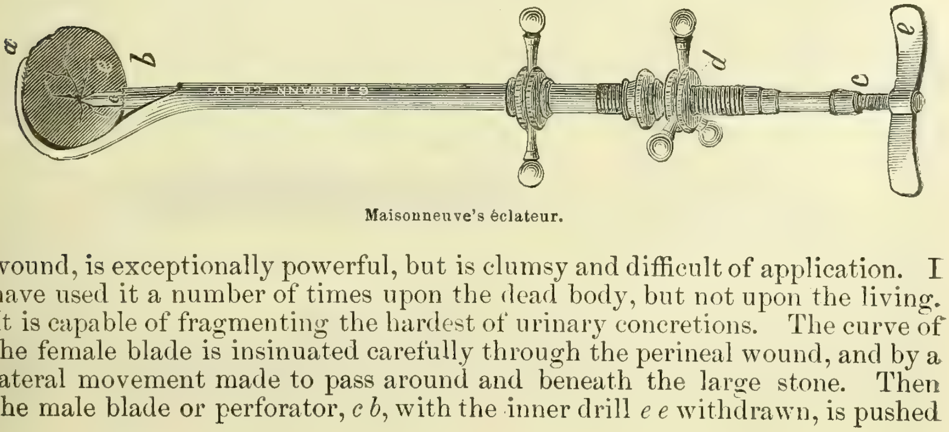
Forceps to crush large stones have been devised in great variety. One such instrument in common use has solid jaws, with a ridge of central teeth projecting backward in either jaw (Fig. 1257), and an adjustable hook and screw which are attached to the handles after the stone is caught, and which allow the screw-power to be brought to bear upon the stone. This forceps resembles Dolbeau's lithoclast. A number of other ingenious lithoclasts are used, most of which will readily break a phosphatic stone as large as they can grasp, but fail with an oxalate-of-lime stone. Maisonneuve's instrument, the *éclateur* (Fig. 1258), for the fragmentation of very solid stone through a perineal wound, is exceptionally powerful, but is clumsy and difficult of application. I have used it a number of times upon the dead body, but not upon the living. It is capable of fragmenting the hardest of urinary concretions. The curve of the female blade is insinuated carefully through the perineal wound, and by a lateral movement made to pass around and beneath the large stone. Then the male blade or perforator, *c b*, with the inner drill *e e* withdrawn, is pushed

Fig. 1257.



Crusher, or brise-pierre.

Fig. 1258.



Maisonneuve's éclateur.

down against the calculus and held firmly in place by turning the wheel *d*. Finally, the central drill at the end of the inner shaft *e* is by a rotation of the handle made to perforate the stone, and by further force exerted upon the wheel *d*, fragmentation is accomplished.

A straight metallic tube (Fig. 1259), half an inch in diameter, with an obturator, is useful in washing the bladder, and for the same purpose a metallic tube one-sixth inch in diameter, having a rounded head of hard rubber about half an inch in diameter with numerous perforations looking backwards (Fig. 1260); a Davidson's or other syringe with a suitable nozzle, and a piece of rubber pipe to form connections, complete the washing apparatus.

Fig. 1259.

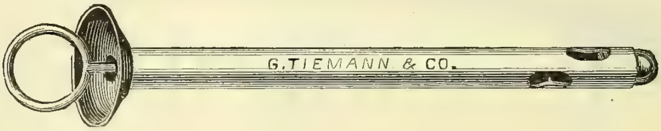
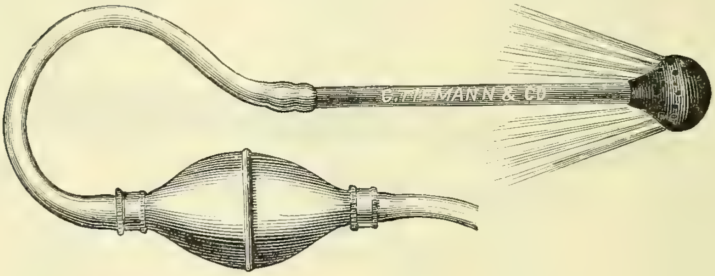


Fig. 1260.

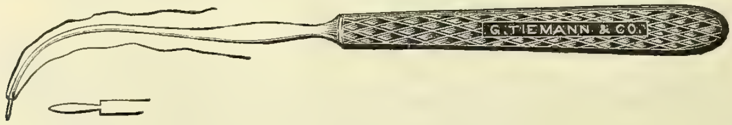


Tubes for washing out bladder after lithotomy.

The devices for arresting hemorrhage which have received approval over and above the common application of the ligature, and the use of heat, cold, and astringents, are seven. Of the seven, three are varieties of plugging, suitable for deep venous hemorrhage. They are the rectal tampon, the shirted canula, and the air-tampon. The four appropriate for a deep arterial hemorrhage are: (1) Horner's awl; (2) Thompson's tenaculum; (3) forcipressure forceps; (4) Gross's artery compressor.

Horner's awl (Fig. 1261), is a curved needle in a fixed handle. The thread is looped over the shoulder near the point, and the needle is passed along the inner side of the ascending ramus of the ischium from behind the pudic artery, starting near the tuberosity and coming out toward the surface, so that the thread may be caught, the awl withdrawn, and the solid fleshy mass

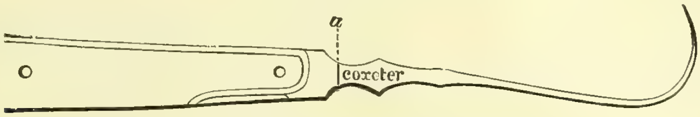
Fig. 1261.



Horner's awl.

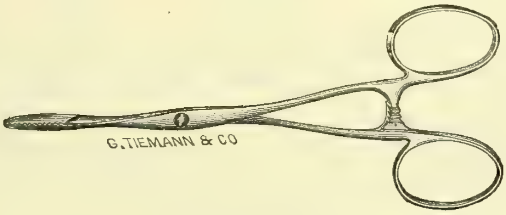
containing the artery ligated. Thompson's tenaculum (Fig. 1262) unscrews at the handle, *a*. The tenaculum including the vessel is tied in, separated from the handle, and left in the wound. The forcipressure forceps (Fig. 1263) is the best instrument for picking up any bleeding point that can be seen. The instrument may be locked, and left in the wound twenty-four hours or longer. Gross's artery compressor (Fig. 1264) is a similar contrivance, not as easy of application.

Fig. 1262.



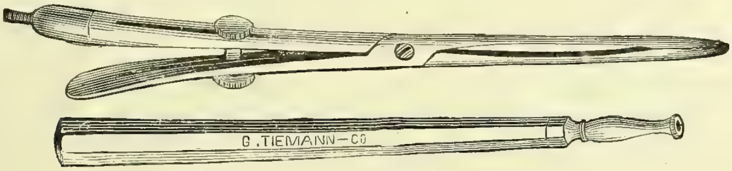
Thompson's tenaculum with detachable handle.

Fig. 1263.



Forcipressure forceps.

Fig. 1264.

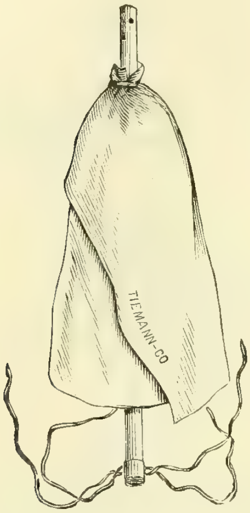


Gross's artery compressor.

The rectal tampon is highly spoken of by Kerr, of Canton. The centre of a square piece of cloth, well oiled, is pressed into the anus, and a narrow roller bandage packed gradually into it until enough pressure has been made upon the deep parts of the wound to arrest all hemorrhage. Sometimes a little digital pressure is made upon the tampon for a few hours, the plug being pushed up against the symphysis. An anodyne may be required to allay tenesmus while the tampon is in place. Kerr says that from six to eighteen hours is long enough to allow the tampon to remain.

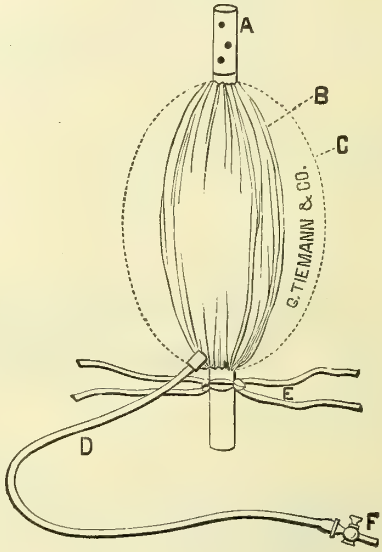
The shirted canula (Fig. 1265) is a tampon consisting of a central tube of metal, around which near one end is gathered the small opening of a conical bag of coarse muslin. The bag is greased and inserted well into the wound, so that one end may lie in the vesical cavity. The conical sac is now stuffed on all sides with a thin roller bandage, until enough pressure has been brought to bear upon the sides of the wound to arrest all oozing, and then the tube is tied in. This is an excellent instrument, and even arterial hemorrhage may be arrested by its careful use. It is allowed to remain twenty-four hours or longer, according to the extent and kind of hemorrhage for the arrest of which it has been employed. The urine escapes through the tube, and generally but little complaint is made of the pressure. It is unpacked by withdrawing the roller bandage before removal. A shirted canula may be improvised in a moment, in case of emergency, from a catheter and a square piece of muslin with a small hole in its centre.

Fig. 1265.



Shirted canula for plugging the wound after lithotomy.

Fig. 1266.



Air-tampon for hemorrhage after lithotomy.

A modern improvement upon the shirted canula is the air-tampon of Buckston Browne (Fig. 1266), the invention of which is ascribed by the French to Guyon. Both gentlemen undoubtedly devised the same instrument, each without the knowledge of the other. The figure shows Browne's tampon. It is a central tube A, surrounded by a thin rubber bag B, which in its turn is inclosed in a bag of thin swan's-down calico, to prevent bursting of the rubber bag, and to insure against its slipping out of place when once distended in the wound. The dotted lines C, indicate the degree of distention which is possible. D is the tube, with stopcock F, by which the rubber bag is to be distended with air or water, and E the strings for tying in the entire apparatus.

Guyon's tampon is a simple oval rubber bag over a hollow tube.

The English instrument-makers, Matthews Brothers,[1] claim to have devised and introduced this instrument, and add that Bryant in his "Manual for the Practice of Surgery," 1872, described their tampon five years before the appearance of Mr. Browne's article in the Lancet. Their tampon was intended to be distended with cold water.

This instrument is vastly the best single means of arresting hemorrhage after lithotomy which is at the surgeon's command. It is a perfected shirted canula. Its introduction, well greased, is very easy; it will arrest arterial as well as venous hemorrhage. Cold or heat may be applied to the wound without removing the tube from its place, simply by substituting hot or cold water for air. Its pressure is uniform and cannot harm the tissues. It causes less pain than any species of plugging. It insures free drainage for the urine, and allows the vesical cavity to be irrigated without removing the instrument.

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[1] Lancet, April 19, 1884, p. 738.

It must be remembered that if the rubber is old it becomes brittle and bursts with distention. It is not well, therefore, to trust to this instrument alone. The surgeon should carry an ordinary shirted canula as well as the tampon.

The tampon is removed in not less than twenty-four hours. It has been left in several days with no disadvantage.

Anatomy of the Perineum.—It is immaterial whether we consider the perineum to be the whole of the inferior strait of the pelvis, as English authors do, or only the musculo-membranous plane which forms the anterior triangle, bounded by the rami of the ischium and pubis and by the ano-bi-ischiatic line, as is done by French writers. This triangle is really the important part in which all the work goes on in perineal lithotomy. A clear idea of the anatomy of this anterior region is essential to an intelligent operation, and a mental picture of the parts within is a guide of no mean importance to the point of the surgeon's knife.[1]

The object of the operator is to pass, in the young child below, in the old subject to the left side of, the bulb, by pushing the latter out of his way from the deeper parts of the wound before his knife enters the urethra. The objective point in the urethra is the membranous portion of the canal, a little in front of the apex of the prostate. To reach it the posterior fibres of the accelerator urinæ must be cut through, but the bulb and its artery should be spared, if possible. The structures which must of necessity be divided in lateral lithotomy, are the perineal integument and superficial fascia, some external hemorrhoidal vessels and nerves, the posterior fibres of the accelerator urinæ muscle, some superficial perineal vessels and nerves, the transverse perineal muscle and artery, the deep perineal fascia, some anterior fibres of the levator ani, a portion of the compressor urethræ, the membranous and prostatic urethra, a part of the neck of the bladder, and a part of the prostate.

The structures to be avoided are the bulb and its artery (by starting the incision to the left of the raphe and not too far forward), the rectum (by keeping away from the middle line), the pudic artery (by not cutting too far outwards), all but a small part of the vesical neck (by maintaining the knife at a proper angle, and by not carrying the incision too far backwards).

It is well also to bear in mind that the pudic artery, ordinarily out of the way along the outer border of the perineal triangle, sometimes follows an anomalous course. Dubreuil has encountered it in the middle line, and Richet has found it nearly in the position normally occupied by the transverse perineal. The artery of the bulb, also, sometimes starts from the pudic opposite the tuber ischii, and crosses the field of the incision in its passage toward the bulb. The accessory pudic may be divided at the upper extremity of the prostate, if the incision there be too deep, and it must be remembered that the veins about the prostate, particularly in old people, are very large and sometimes bleed alarmingly.

Mode of performing the Lateral Operation.—The veteran, skilful operator sometimes plunges his knife through the skin, into and along the groove of the staff, and into the neck of the bladder, at one thrust, cutting his way obliquely out and finishing the incision in a single movement. But such a brilliant manœuvre is not desirable for general adoption. The incisions may be best executed by dividing them into three steps; the superficial incision, opening the urethra, and the deep incision.

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[1] Such a mental picture can only be obtained as the result of numerous and careful dissections. No anatomical plates can represent it in any fair way. The operator should have become familiar with the parts which he is about to cut by having frequently handled them, and he should be able to picture to himself each plane of the perineal tissues, with its muscles and vessels, as the patient lies before him on the table—at his mercy. If the surgeon cannot present this picture to his mind, he is not ready to operate.

For the *superficial incision* the operator places his left index finger upon the raphe of the perineum to steady the tissues centrally upon the groove of the staff, and enters the point of his scalpel boldly at a point about one inch and a quarter in front of the anus, and about one-third of an inch to the (patient's) left of the raphe. The incision is begun on the left of the raphe in order the more certainly in the second step of the operation to escape the bulb. The plane of the blade is directed so that the superficial incision shall lie in the perineum midway between the anus and the tuber ischii. The point of the knife is made to penetrate directly inward toward the groove of the staff, more or less deeply according to the fatness of the individual, but sufficiently to cut well through the superficial tissues at the first stroke. From thence the incision is continued downwards and outwards about two and a half inches in a line midway between the anus and the tuber ischii, growing somewhat more superficial toward its termination.

The left index finger now enters the wound, and pushes the bulb of the urethra towards the patient's right, while the pulp of the finger depresses the rectum and the nail is made to feel for the groove in the staff at a point as far back toward the membranous urethra as possible. A few light touches with the point of the knife, made always in the line of the first incision, facilitate the approach of the finger to the depths of the perineum.

The second step in the operation, *opening the urethra*, commences when the finger-nail, deep in the perineum, recognizes the inner edge of the groove in the staff. The point of the scalpel is now conducted along the nail, well backward, and made to enter the groove, when the operator and the holder of the staff at once recognize the rough feeling of contact between the two metallic surfaces. Now the back of the point of the scalpel, pressed up firmly into the groove of the staff, is run directly inwards, the blade being held more horizontally as it advances, until the point has entered the neck of the bladder. Then the handle of the knife is slightly depressed, and its blade made to cut its way outward in the line of the original incision, enlarging it more or less according to the known dimensions of the stone to be extracted, thus terminating the *deep incision*, and completing the third step in the cutting operation.

Exactly what amount of pressure to place upon the blade of the knife in executing this third step, is a matter of judgment and of individual tact and experience, which cannot be written down in words. The old operator needs no caution upon this point. The young operator should remember that his caution is liable to make him incise the neck of the bladder too modestly, and that more injury will be caused by rude efforts at extracting a large stone through too small an incision, than would follow a reasonably free incision of the bladder's neck made at one stroke downward and outward, and in a position to drain itself effectively.

Any sharp arterial spurt noticed during any of these incisions may be attended to by ligature at once, but ordinary bleeding may be disregarded. A gush of bloody urine, more or less copious according to the previous distention of the bladder, follows the withdrawal of the knife on the last incision. The left index finger is at once inserted into the bladder along the groove of the staff, and the latter is withdrawn. The finger, now within the bladder, generally touches the stone, arrests the further outflow of urine, dilates the neck of the bladder, and appreciates the depth of the incision in the same. If this be considered insufficient, the Blizard knife is inserted along the finger, and, so guided, enlarges the original deep incision, cutting evenly outward and downward, so that the bottom of the wound may be one inclined plane, to such a depth as the operator may deem prudent. A further liberating incision into the prostate and neck of the bladder may be made upon the patient's right side, if the operator thinks it necessary.

Now the operator slides in the closed forceps upon his finger, dilating the neck of the bladder as he does so. Then taking one handle of the forceps in each hand, and gently but widely opening both blades toward the roof of the bladder, he elevates the handles, keeping the blades distended, and upon gently closing them laterally it is not improbable that he will seize the stone. If not, a second attempt is made in the same direction, or, failing again, one blade is depressed into the floor of the bladder by half rotating the instrument while the other is widely raised toward the roof. Now upon closing the blades the stone is pretty sure to be found within their grasp. If not, other efforts are made in various degrees of rotation of the instrument, perhaps aided by a finger in the rectum to raise the floor of the bladder, and finally the stone is seized. In a case of large prostate, with a bas-fond, the curved forceps should be used, and opened laterally upon the floor of the bladder. The same instrument may successfully seize a stone retained at the roof of the bladder, behind the pubis, in a position which would make it almost inaccessible to the straight forceps. The operator must now assure himself, if the stone is large, that it has been caught in one of its smaller diameters. This he may do by feeling the presenting portion of the stone through the wound as well as through the rectal wall.

Extraction is accomplished by traction from side to side and outwards, two-thirds lateral and one-third extractive, not directly outwards, but outwards and downwards in the axis of the inferior strait of the pelvis, easing the soft parts with a finger in the wound, and slipping them over any asperities in the presenting portion of the stone, carefully, slowly, but continuously, until the foreign body is removed. Sometimes the perineum is too deep for the finger. In such a case the crested scoop or blunt gorget may be used as a guide for the forceps. The finger or a searcher should lastly be introduced to explore for any further stone, then attention should be given to hemorrhage, and finally the bladder should be washed out with warm water.

In the child, the operation is much simpler. The urethra has no bulb to be feared before puberty, and for all practical purposes the prostate does not exist. The staff can be plainly felt through the thin tissues of the perineum. The first incision generally touches the instrument, or even enters its groove. In the latter case it should be slid along the groove for a certain distance, so as to make a clean opening into the urethra, which may be immediately encountered by the finger as it enters the wound, as otherwise there would be danger of opening the urethra in two places. The Blizard knife completes the operation, the neck of the bladder and the whole of the prostate being cut through at one incision, which should be relatively quite free, for if the neck of the bladder be not sufficiently incised in the young subject, there is danger, upon introducing the finger for purposes of dilatation, of tearing the membranous urethra across, and of pushing the neck of the bladder, undilated, before the finger upwards into the pelvis, an accident greatly to be deplored both on account of the subsequent difficulty of entering the bladder, and particularly on account of the traumatic stricture in the membranous urethra to which the transverse rent gives rise. Small, straight forceps easily extract the stone from a child, and the getting up is generally speedy.

After-treatment.—When bleeding has been arrested and the bladder thoroughly washed—a thoroughness the more requisite if the stone has been at all broken or even clipped during extraction—the patient is put to bed, preferably upon a hard hair-mattress upon which has been placed a rubber cloth, and beneath the hips a folded sheet to absorb the urine as it flows away. This sheet must be often changed as it becomes moistened with urine, and the buttocks and perineum of the patient should be washed several times a day with warm water and alcohol, and afterwards lightly anointed with vaseline, to keep the skin in good order, particularly if the patient be fat and debilitated, and if the urine be ammoniacal. The patient may turn if he pleases, but he usually prefers to lie upon his back.

Although surgeons differ as to the advisability of tying in a catheter, the weight of authority is largely against it. It is difficult to see in what way it could be of any benefit in an ordinary case. It could not possibly prevent contact of urine with the cut surface, and it could hardly fail to prove a source of uneasiness, even if it did not set up local irritation.

The urine at first flows away freely through the cut. Then, as inflammatory swelling comes on upon the second or third day, most or all of it may pass through the urethra; but when suppuration commences and the turgescence of the tissues subsides, the urine again escapes through the perineum, at first involuntarily, then, as the neck of the bladder recovers its retentive power, at the patient's will, finally resuming its natural channel as the wound in the perineum closes.

This takes a varying period. Habitually more prompt in children (averaging perhaps ten days), and in persons in good health, it becomes longer with advancing age and in cases of debility. Three weeks is a fair time to count as a very moderate interval for repair to perfect itself in an ordinary case. Six weeks often pass before the wound is healed, and the time may extend itself to months in unfavorable cases.

It is more surgical in principle to allow the wound to heal by granulation, and to favor drainage, thus opposing any tendency toward infiltration, than to make any attempt to secure quick union. Yet primary union has been not only sought for but obtained.

Professor Dudley,[1] of Kentucky, recorded primary union after perineal lithotomy 8 times in 135 cases. Mr. Crichton,[2] of Scotland, made even a better record, claiming success 23 times in 200 operations, and Bouisson,[3] of France, collected some interesting examples, and advocated the attempt to secure quick union in certain cases, particularly when the stone was small, and when the median operation had been employed.

Tolet, Boudou, and Ollivier have reported cases of quick union. It can hardly be called immediate, for although the urine escapes by the meatus from the first, yet the wound is not entirely healed for several—often as many as six—days. Crichton applied a simple wet compress to the wound and tied the legs together, using a warm sitz-bath in case of retention, and confining his attempts at quick union to patients in flourishing health and cases of small calculi. These attempts at quick union are of doubtful advantage, the few days that may be saved not making up for the increased risk of urinary infiltration.

Even with the wound open, a child sometimes will get up and play about within a day or two, delighted to be rid of his former tormenting pain. An adult also often gets up after the bladder has resumed its retentive power, but before the perineal wound has healed. In cases of feeble persons, such hasty movements may entail subsequent perineal fistula, but in healthy individuals they usually do not. A little opium may be required for the first day or two, to ease pain, if it be great, and some quinine and an alkaline diuretic are not out of place—although a milk diet generally answers for the latter. A chill and more or less fever before suppuration sets in are not infrequent, and a laxative upon the third day is often serviceable. After suppuration occurs, and granulations cover the wound, but little pain is experienced, and recovery is merely a matter of time.

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[1] Translvania Journal of Medicine and the Associated Sciences, vol. ix. p. 288. 1836.

[2] British and Foreign Med.-Chir. Review, July, 1854.

[3] De la réunion immédiate à la suite de l'opération de la taille. Gaz. Méd. de Paris, 1867, pp. 704 *et seq.*

The causes of death in fatal cases are much the same as those which have already been considered in speaking of lithotrity (p. 215), except that hemorrhage and shock naturally play a larger part here than in the non-cutting operation. Rouxeau estimated that severe bleeding occurred in one-seventh of all cases operated on, and Bégin charged 25 per cent. of the bad results that followed lithotomy to hemorrhage.[1] Infiltration of urine is also more likely to occur than after the crushing operation, and therefore cellulitis, septicæmia, etc.

Obstacles Encountered before the Operation.—Aside from the questions of renal or other organic disease, and of the condition of the heart and lungs as bearing upon anæsthesia, three minor obstacles have been encountered by surgeons when considering the question of perineal lithotomy, viz., an impassable urethra, an obstacle to the left perineal incision, and a rickety pelvis. (1) If the urethral obstacle be an anterior stricture, internal urethrotomy will overcome it; if a tight, deep stricture, it may be divided as the first step in lithotomy, which should then be median. Furneaux Jordan, in such a case, made his diagnosis by acupuncture through the perineum, and cut his patient without a guide. If the obstacle be a prostatic lobe or tumor, perineal lithotomy may still be performed with the secondary object of removing the growth as one of its steps. (2) In some cases of anchylosed hip-joint the thigh is drawn across in such a way as to make section of the left half of the perineum impossible. I have seen this, the section being made in the median line. Gross reports that Pope, of St. Louis, cut a patient toward the right side in such a case, and he refers also to Zeiss's dilemma, who found a congenitally displaced testicle in the left side of the perineum, and so cut to the right. (3) In rickets the pubic and ischial rami may leave a slit between them so narrow as mechanically to oppose lithotomy. In such a case the narrowness has only to be appreciated to immediately suggest supra-pubic lithotomy, for the bladder would necessarily be high up. Thompson notes the case of a boy of four years, whose antero-posterior pelvic diameter was only an inch, and yet whose stone was extracted through the perineum.

Complications during Perineal Lithotomy.—Most of the complications likely to occur in perineal lithotomy are identical, whether the section has been lateral, bilateral, or median, and they may therefore conveniently be considered here.

Such complications as shock, heart failure under an anæsthetic, etc., need not be referred to. The patient who died of fright, while Desault was tracing out with his finger the proposed line of incision upon the perineum, cannot properly be classed among the victims of lithotomy.

Complications occur during the operation, after it, and as an ultimate result.

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[1] Villeneuve, Rev. de Chir., t. iii., Sept. 1883, p. 665.

(1) *Possible Complications during Perineal Lithotomy.*

1. Failure to enter the bladder.
2. Incision of the body of the bladder.
3. Wounding the rectum.
4. Hemorrhage.
5. Rigidity of the neck of the bladder.
6. Great depth of the perineum.
7. Enlargement of a prostatic lobe.
8. Tumor.
9. Failure to find stone after lithotomy.
10. Abnormal position of the stone due to—
    - *a.* presence of a bas-fond.
    - *b.* its being entrapped by muscular contraction.
    - *c.* " " adherent.
    - *d.* " " encysted.
11. Wounding the bladder from within.
12. Foreign body as a nucleus.
13. Faulty seizure of the calculus.
14. Multiple calculus.
15. Friable calculus.
16. Great size of calculus.
17. Aspiration of air by the rectum.

(2) *Possible Complications after Perineal Lithotomy.*

1. Hemorrhage.
2. Filling up of the bladder by clot.
3. Retention of urine.
4. Suppression of urine.
5. Fragment left behind.
6. Phosphatic incrustation of the wound.
7. Diphtheritic deposit upon the wound.
8. Epididymitis.
9. Sloughing of the rectum.
10. Cellulitis and infiltration.
11. Phlebitis and pyæmia.
12. Cystitis.
13. Surgical kidney.
14. Peritonitis.
15. Tetanus.

(3) *Possible after-effects of Perineal Lithotomy.*

1. Incontinence of urine.
2. Impotence.
3. Sterility.
4. Perineal fistula.

(1) *Possible Complications during Perineal Lithotomy.*—

1. *Failure to enter the Bladder.*—This accident has occurred more than once, particularly in the case of children. It is due to the fact that the incision into the urethra and prostate is not ample enough to admit the exploring finger, and that the latter either pushes off the bladder from the urethra, or else, failing to enter the canal at all, wanders hopelessly in the cellular tissue of the recto-vesical space. The accident may be avoided in any case by passing a director along the groove of the staff before the latter is withdrawn from the bladder, and then using the director to guide the pulp of the finger into the bladder. The peculiar sensation imparted to the finger as it passes through the neck of the bladder, when once felt even upon the dead subject, is sufficient to allow the careful operator to recognize the parts and determine whether the neck of the bladder is entered by the finger or not.

If the accident should occur, by carefully following along the roof of the urethra, the apex of the prostate must be sought, the bladder opened, the stone extracted, and free drainage established with a large rubber catheter passed through the wound, where it is to be retained until free suppuration sets in. The accident is a serious one, but not necessarily fatal. Cellulitis and infiltration of urine are to be feared.

A false passage made by the staff can always be guarded against, if the operator feels the stone with his staff before making his first incision. In children, a false passage may be made by failing to recall the sharpness of the urethral curve; in adults, on account of a stricture or prostatic enlargement. The dreadful error of cutting upon a staff which has made a false route is only to be mentioned to be guarded against. Thompson has referred to two cases in which it was proved by autopsy that the point of the staff had penetrated the roof of the bladder, thus leading to a fatal termination. He thinks that this perforation of the thin wall of an empty bladder may be the cause of certain rapidly fatal cases of peritonitis after lithotomy, and counsels the use of a staff with short curve.

2. *Incision of the Body of the Bladder.*—This incision is habitually made in children. It is also often made where large stones are extracted from the adult. In some of the operations of the earlier lithotomists the body of the bladder was always incised. The result of this depth of incision in the adult is not necessarily fatal, and, while the careful operator avoids the mistake, he may make it unwittingly, and yet the case progress satisfactorily.

3. *Wounding the Rectum.*—The rectum has been wounded at the hands of nearly all the best operators—Thompson confesses to four such cases—either because the staff has been improperly held, or the finger not used to depress the loose folds of the bowel during the deep incision, or because the gut has been very large (in old men) or much distended, or because the knife in the deep incision has not been sufficiently lateralized, or because in withdrawing a rough stone through a narrow external wound the rectum has been torn into.

The lower down toward the sphincter that the opening occurs, and the smaller it is, the more readily does it heal, particularly if the subject be young and healthy; but the accident is always a disagreeable one, and it may entail urethro-rectal fistula.

The treatment is at first expectant, as most cases recover during the healing of the wound. The rectum should be kept empty, and the wound should be frequently and freely irrigated. If fistula ensues and is well above the sphincter, after it has been allowed to contract during several months, it may be treated by cauterization with the electro-cautery or thermo-cautery, but only if the opening is not larger than a crow-quill. For larger openings a plastic operation should be attempted, by sliding the mucous membrane over the orifice, the margins of which have been previously made raw.

Such an operation is exceedingly difficult, because the fistula usually lies at the bottom of a sort of funnel, and stretching the sphincter makes the parts tense and deepens the funnel. If the fistula is low down, just above the sphincter, after due time it should be freely laid open through the sphincter and treated like an ordinary fistula in ano, or the edges may be freshened and brought together with silver wire.

4. *Hemorrhage.*—Moderate bleeding may be disregarded. An arterial spurt, however, should always receive attention at the time of its occurrence, unless it is made during the last incision, when the stone should be speedily extracted, and then the hemorrhage attended to by ligature or by some of the means already detailed (p. 268). The forcipressure forceps and the rubber tampon make hemorrhage much less to be dreaded than formerly. Very hot water injected into the wound is often efficient against oozing.

5. *Rigidity of the Neck of the Bladder.*—This is a complication encountered in old men, entirely apart from the size of the prostate. Thompson insists upon its importance. The neck of the bladder, even when incised, does not yield to dilatation, and it becomes necessary either to tear it in extracting the stone, or to cut it freely in one or more directions. The latter course is decidedly preferable, since, if an opening of a given size must be made, it is better to make it cleanly with the knife than rudely while extracting the stone.

6. *Deep Perineum.*—When the finger cannot reach beyond the prostate, or if the stone be small and so much dilatation of the neck of the bladder is not desired as would be effected by passing the forceps over the finger, a crested scoop or blunt gorget is generally used to conduct the forceps to the stone.

In cases of deep perineum also, where the bladder is so far away that the forceps cannot readily grasp the stone, the latter may be pushed down within reach by means of firm pressure made by the hand upon the hypogastrium.

7. *Enlarged Lobe of the Prostate.*—When the prostate is so large as to form a bas-fond in which the stone lies, the latter may be readily seized by the curved forceps, or the stone may be lifted out of its pouch by a finger in the rectum—the operator's finger, to avert an accident which occurred to Deschamps, who seized in his forceps the finger of the assistant who was trying to elevate the stone. When a third lobe is prominent, it may be accidentally pinched off and drawn away in the bite of the forceps, or may be deliberately removed as a step in the operation. I have done this with the effect of restoring to the patient the power of urination without a catheter, a power which he had totally lost for four years. Many operators speak well of the practice, while others condemn it. I believe the weight of authority to be in its favor.

Sometimes, in incising a large prostate, one of the central, encapsulated, muscular tumors which at times form part of the growth is cut into, liberated from its capsule, and extracted, either designedly or by accident, in the jaws of the forceps. Such an accident in most reported examples does not seem to have interfered with the happy progress of the case, but in one instance Gross[1] believed that the cavity which was left behind became a suppurating pouch, and increased the difficulty of urination.

8. *Tumor.*—When a tumor or fungus is encountered in the bladder, as a complication of stone, if it can be safely removed it should be taken away with forceps or the sharp spoon, as a final step in the operation.

9. *Failure to find Stone after Lithotomy.*—Sometimes the stone is so small that the gush of urine when the bladder is first opened washes out the concretion, which may be lost among the blood-clots, sponges, or towels. Such an accident has been most often noted in the case of small children, in whom the bladder contracts vigorously and in whom the cut is relatively free. With modern means of measuring the calculus such an accident ought seldom to occur; certainly never in the case of an adult, from whom so small a calculus could be more appropriately removed by litholapaxy. Occasionally the stone lies shrouded in a blood-clot or thick layer of mucus upon the floor of the bladder, and so escapes detection. An efficient search with the finger or forceps will, however, detect a movable foreign body and overcome the embarrassment. Finally, the stone may not be found because it does not exist. The names of Cheselden, Roux, Dupuytren, Crosse, and many others distinguished in the history of lithotomy, have been coupled with failures of this sort. Modern means of diagnosis should render this accident impossible.

10. *Abnormal Position of the Stone.*

(*a*) The complication caused by the stone lodging in the *bas-fond* of the bladder has been already considered under the head of enlarged prostate.

(*b*) *Stone entrapped by Muscular Contraction.*—If the bladder be large, and with thin, atonied walls, the stone may become entrapped in some of the loose vesical folds during the collapse which occurs as the water rushes out, and may thus elude a hasty search. Distention of the bladder with warm water, and search with blunt instruments and small, smooth forceps, will dislodge the stone without injury to the vesical wall. If the bladder as a whole contracts down forcibly upon the stone, anæsthesia should be pushed, and a curette or the scoop employed.

Sometimes the bladder is in a state of hour-glass contraction, retaining the stone at the top of the fundus; or a partial contraction may retain it firmly above, behind the pubis. In these instances the employment of the curved forceps, inverted, is of great value, but considerable caution should be exercised as to the amount of force employed. The finger or the scoop as a lever, and hot water injections, all deserve trial.

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[1] Trans. Path. Society of Phila., vol. iv. p. 153.

(*c*) *Adherent Stone.*—When the calculus is adherent to a flat surface, it either crumbles during removal, or may leave some particles still attached to the fungosities upon the site on which it rested. It should be extracted as in the case of faulty position due to spasmodic muscular action noted above ; but after it has been removed the scoop or currette should be freely used, to scrape off from the bladder both the adherent particles and the granulations in which they lie. The after-treatment of such a case calls for vesical irrigation with a dilute nitric-acid solution, to guard against the re-precipitation of a phosphatic layer upon the abraded surface.

(*d*) *Encysted Stone.*—An encysted stone is either partly within the bladder and partly encysted, the neck of the cyst forming the obstacle to removal, or the orifice of the cyst is so small that to all intents and purposes the calculus is extra-vesical.

For the former set of cases, after the part projecting into the bladder has been removed, or before, in some cases, the operator endeavors with his finger-nail, or a director, a searcher, a scoop, or other elevator, to dilate or slightly tear the neck of the cyst and work out the calculus. In this manœuvre, pressure upon the hypogastrium or through the rectum may be of great assistance. If moderate manipulation fails to dislodge the stone, a curved, probe-pointed, long bistoury may be used with great caution upon the finger as a guide, to cut moderately the constricted edge of the neck of the cyst in one or more places. Such use of the knife involves risk, and it rests with the operator to decide according to the circumstances of each case whether to assume the risk, or to leave the stone in place and the operation unfinished, or to resort to supra-pubic section.

In the case of a large pouch connected with the bladder, and containing a small stone, the neck of the pouch may be dilated with the finger or small forceps, and the stone reached. When the stone is practically outside of the bladder, or in a dilated ureter, some operators prefer to leave it untouched. Thompson acted in this way in the presence of a stone in the ureter. It is plainly the surgeon's duty to cut scantily in such cases.

11. *Wounding the Bladder from within.*—Such an accident may occur through carelessness in the use of the staff or knife, or by seizing and tearing away a portion of the mucous membrane and muscular coat with the stone, in the grasp of the forceps. These mishaps are to be deplored and to be avoided by proper care, but the last-named accident, which is far from uncommon, is by no means always attended by serious consequences to the patient.

12. *Foreign Body as Nucleus.*—Generally the nucleus comes out with the entire stone; but the latter may crumble, leaving as a nucleus some object requiring especial care for its safe removal.

13. *Faulty Seizure of the Stone.*—This should be corrected by rotating the stone with the finger passed through the wound, or into the rectum, or by dropping the stone entirely and attempting again to catch it in a narrower diameter.

14. *Multiple Calculi.*—The first stone extracted is examined for facets. If they are found, it is certain that other stones are present; but in any case, whether the first calculus be facetted or not, search should be made to decide that the bladder is empty before the operation terminates. A partition may exist, on the other side of which more calculous material may be found. Collot operated upon a bladder from one side of which he extracted four and from the other eleven calculi.

15. *Friable Calculus.*—The stone may crumble in the jaws of the forceps. This calls for the careful use of the scoop, and for repeated washings with warm water, preferably through a retrograde canula, and for especial care in the final search that no fragments be left behind.

16. *Great Size of the Calculus.*—When the stone proves too large to be extracted safely, the choice lies between opening the bladder above the pubis or fragmenting the stone before extraction. If more than one diameter of the stone exceeds two inches, the prudent surgeon generally considers it too large for safe extraction unbroken through the perineum. If very hard or very large, therefore, it naturally calls for the supra-pubic operation, a manœuvre often successfully practised after a previous perineal opening. In fact, the drainage afforded by the latter is probably no inconsiderable help toward the success of the high operation in these cases. If the stone is broken up before extraction, the bladder requires free irrigation, as in the case of friable calculus.

17. *Aspiration of Air by the Rectum.*—This complication has been noted once by Agnew. His patient's sphincter ani, under partial anæsthesia, relaxed rhythmically with the relaxations of the diaphragm and contracted with its contractions. In this way the rectum became fully distended with air sucked in from the outside. With complete anæsthesia the phenomenon ceased.

(2) *Possible Complications after Perineal Lithotomy.*—

1. *Hemorrhage.*—Secondary hemorrhage may come on after lithotomy. I have only encountered it once, and then arrested it with a shirted canula.

2. *Hemorrhage into the Bladder.*—The bladder may fill up with blood-clot after the operation. The accident is rare. Various counsels are given by authorities: to break up the clot and pump or wash it out, to inject a strong solution of pepsin in order to dissolve the clot, or to leave it alone, calming the patient with opiates. The latter course seems to me preferable. The presence of the clot affords a pressure which is the best guarantee against continuance of the hemorrhage, opiates will quiet the patient, and, unless the mass is enormous and occludes the ureters, urine will trickle past the clot and presently dissolve it. When it softens and begins to come away, its exit may be hastened by the use of warm antiseptic irrigations with a soft catheter. If the pressure is so great that suppression seems imminent, there is no escape from the necessity of breaking up and evacuating the clot. The bladder may then be copiously irrigated with a very hot and strong solution of alum, to arrest further hemorrhage and insure a softness of whatever clot may subsequently form. An alum clot is much better than a subsulphate-of-iron clot.

3. *Retention of Urine.*—Inflammatory swelling, or obstruction by clot, may cause retention of urine. In such a case the physical signs attest the fact, and the failure of the customary flow of urine through the wound confirms it. A female catheter passed through the wound relieves the bladder of its accumulated load. Usually this complication does not last long.

4. *Suppression of Urine.*—Of far graver significance is the occurrence of suppression. A chill may precede or accompany it, and rapidly fatal results may ensue, or the urine may again begin to flow with periods of freedom and periods of scantiness, life terminating finally with very high temperature, symptoms of acute uræmia, etc. The autopsy shows multiple abscess in the kidney. The suppression may be only partial, with or without chill (urinary fever). It is not caused by ordinary surgical fever. Its gravity depends on the accompanying signs. Heat, generally applied, poultices and mustard

upon the loins, hot drinks, stimulants, quinine, jaborandi, digitalis, and diuretics, are employed in the treatment.

5. *Fragment left behind.*—Such a complication may manifest itself during convalescence by a return of the old pain, straining, blood in the urine, etc. A search should be made before the wound has closed, and if anything is found the wound should be dilated, a small forceps introduced, and the fragment extracted.

6. *Phosphatic Incrustation of Wound.*—This occurs in the case of feeble subjects, especially in those who have had phosphatic stone with ammoniacal urine and considerable cystitis. A tough, fibrinous exudation forms upon the wound and adheres to it; sometimes indeed it is a thin slough of all the superficial tissues. This layer is infiltrated with triple-phosphate crystals, and its surface is roughened by their deposit. These fibrinous layers, diphtheritic in appearance, line the cut and may extend into and even invade the bladder, being shed from time to time in pieces of varying size. The natural healing of the wound is greatly retarded by this complication, which, according to my experience, is an evidence rather of weakness and lack of vitality on the part of the patient, than of the condition of his bladder, or of the urine which it contained at the time of the operation. Undoubtedly, a bruising of the neck of the bladder or of the track of the wound during the rough extraction of a large stone, would conduce to the formation of slough, and this slough would be covered with phosphates; but the deposit may occur independently of bruising violence. One of the most obstinate cases of this kind that I have ever seen was in the person of a seemingly healthy young man, with acid urine and a healthy bladder. He was cut cleanly in the perineum (cystotomy), as a possible means of relief from an intense neuralgia of the vesical neck.

7. *True diphtheria*, attended with all the general phenomena of the disease, may complicate the perineal wound, but the complication is exceptionally uncommon.

8. *Epididymitis and Orchitis.*—The testicle may become inflamed after lithotomy, shortly after the operation, or as late as the second week. This complication is most common upon the side which has been operated upon (left), and presents no features of moment. It is due to injury of the seminal duct, or to subsequent inflammation near the orifice of the latter. Usually only the epididymis is involved, and resolution follows in due course. Sometimes true orchitis sets in, and this may terminate in suppuration.

9. *Sloughing of the Rectum.*—An eschar may form, due to the bruising violence of extracting the stone, or to the lack of vitality of the tissues, and this may involve the rectal wall, and, separating after a few days, disclose the fact of rectal perforation by the escape of intestinal gas through the wound. The subsequent fistula is treated as already directed in cases of similar fistula caused primarily by the surgeon's knife.

10. *Cellulitis and Urinary Infiltration.*—As to whether pelvic cellulitis after perineal lithotomy is an effect or cause of urinary infiltration, has been a matter of grave dispute among authorities. Some, like Scarpa and Brodie, fearing infiltration, advise a very limited vesico-prostatic incision, and Reliquet is inclined to do the same. On the other hand, the most successful operators—Martineau, Cheselden, Thompson—have used a free incision, preferring the clean cut to any possible bruising of the tissues while extracting the stone. My belief is that too small an incision is much more dangerous in the case of a large stone than a free cut which will allow extraction without much bruising of the soft parts. In the child, the cellular tissue about the neck of the bladder is very loose, and the whole substance of the prostate is habitually cut through as well as a portion of the body of the bladder; yet

in these cases, even where the urine is ammoniacal, cellulitis and infiltration are the rarest exceptions.

In the aged, the cellular tissue about the base of the prostate is not only loose, but it is also full of large veins, and in this class of cases it is probably more often that cellulitis and subsequent infiltration are due to violence in traction upon the stone, which bruises the cellular tissue, breaks the veins, and excites phlebitis and cellular inflammation—than that simple contact of urine (even under a little pressure) with the cellular tissue about the neck of the bladder first occasions infiltration, and it again cellulitis. Undoubtedly both causes are often combined; the large stone, dragged through an insufficient cut, not only bruises the surrounding tissues but also mechanically tears open the cut widely into the cellular tissue, doing roughly what the knife could have done more surgically. I have demonstrated this fact several times upon the cadaver. A small cut is easily converted into a large tear by dragging through it a stone of disproportionate dimensions.

If the cut goes too far forward in the region of the bulb, and the urine does not escape freely by the wound, infiltration of the scrotum, perineum, etc., are possible.

The treatment of these conditions involves the free use of stimulants and all sustaining measures, incisions where they are possible, drainage, and antiseptic irrigation. When the infiltration is deep, a speedily fatal issue (in two or three days) may be expected.

11. *Phlebitis and Pyæmia.*—These complications occur less often than might naturally be expected, in consideration of the peculiar nature of the parts involved in the operation, the bruising to which they are exposed, and the purulent, putrid, ammoniacal flow from the bladder in which they are often bathed. The bulb may be opened, the large veins at the base of the prostate incised or torn, and the hemorrhoidal veins injured, yet, apart from the general condition already described in speaking of pelvic cellulitis, phlebitis and pyæmia are not common. Thompson, in an analysis of twenty cases of death in the adult, occurring in his own practice after lithotomy, only puts down one as due to pyæmia. Yet the complication undoubtedly does occur, starting in the veins, ushered in by a sharp chill (repeated afterwards at intervals), followed by high temperature, frequent feeble pulse, sweating, great physical depression, and, subsequently, a yellowish tint of the skin and conjunctivæ. Sometimes the veins of one of the thighs become implicated, the circulation of returning blood from the limb is interfered with, and the phenomena of phlegmasia alba dolens are produced.

All complications of this class are of most serious prognosis. Their treatment is conducted on general surgical principles, and includes the use of hot fomentations, local incisions when pus forms, drainage, and irrigation; with quinine, iron, and stimulants, internally, to sustain the vital forces.

12. *Cystitis.*—Cystitis is often relieved by the extraction of the foreign body, and by the rest and free drainage secured to the bladder by the dependent opening in the perineum. Sometimes, on the other hand, on account of violence done, the mucous membrane of the bladder or the walls of the organ inflame in a serious manner.

Shreds of mucous membrane may slough, become detached, and be expelled through the wound, interstitial abscesses may form, and pericystitis, or localized or general peritonitis, may be the outcome of the process. The indications are to wash the bladder frequently with mild, hot, antiseptic solutions, to use hot, local fomentations, to give demulcent drinks, and to carry on a general sustaining and stimulating internal treatment, suitable to low grades of septic inflammation of bad type.

13. *Pyelo-nephritis, the surgical kidney*, is one of the possible sequences of lithotomy. It is announced by a chill, followed by others at varying intervals; pain in the back, on one or both sides; high temperature, going somewhat up and down morning and evening, and interspersed with periods of more or less profuse sweating. The tongue becomes first sticky and coated, then dry and brown, or perhaps glazed, dry, red, and deprived of epithelium over its tip and central parts. The flow of urine varies greatly in many cases from day to day, being sometimes over-abundant, and then being quickly reduced in quantity almost to suppression. Nausea, lack of desire or ability to eat, and hiccough, accompany the later stages of this fatal complication, with delirium, sometimes mild and wandering, with picking at the bedclothes, and sometimes attended by considerable excitement. The patient dies generally with urinary suppression and from uræmia, usually with a very high temperature. The use of morphine, with such sustaining and stimulating articles as the patient can be made to take, and hot local applications, constitute the treatment, and give all the comfort that can be afforded.

My belief is, that this form of kidney-disease, with inflammation of the pelvis, multiple abscesses, and colonies of bacteria in the renal substance, is necessarily fatal. Symptoms resembling those produced by these lesions may occur, and yet the patient recover; but I believe that, in such cases, true pyelo-nephritis has not been the cause of the symptoms.

This complication is not likely to occur except in cases in which the kidneys have been diseased in a chronic inflammatory way before the operation. Old men suffering from long-standing chronic vesical disease, in whom the ureter as well as the pelvis of the kidney is dilated and chronically inflamed, are, of all others, most liable to this complication. It is, according to my experience, the most common of all fatal complications after lithotrity or lithotomy in old men.

14. *Peritonitis.*—This complication may follow lithotomy directly, as a result of perforation of the bladder by the staff or the scalpel; or by a lesion of the peritoneal *cul-de-sac*, when the latter extends very low down and the deep incision reaches too far at the base of the prostate.

Urinary infiltration is the main cause of the mischief in these cases, which are nearly always fatal, although probably not always, for the free drainage may occasionally save the patient. As a secondary complication of interstitial cystitis, pelvic cellulitis, phlebitis, etc., the peritonitis forms part of the general process, aggravating and intensifying it, but not in itself materially adding to the gravity of the more important surgical complications of which it forms a part. The indication in peritonitis is the free exhibition of morphine subcutaneously.

15. *Tetanus* has been recorded as a cause of death after lithotomy.

(3) *Possible after-effects of Perineal Lithotomy.*—

1. *Incontinence of Urine.*—This sequence of lithotomy is happily rare. It is most common in young subjects, but in them may gradually disappear with lapse of time. When it occurs in an old man it is generally rebellious to all subsequent treatment. It is usually caused by violence (laceration, etc.), done to the neck of the bladder during rough efforts at extracting a large stone, where the internal incision is not sufficiently extensive.

The treatment is to try cauterization of the vesical neck (Thompson records one success by this method), and, failing in this, to resort to a urinal. Generally at night, when the patient is recumbent, the incontinence is less marked than during the day.

2 and 3, *Impotence and Sterility.*—The latter of these two complications—

both of which are happily very rare as after-effects of lithotomy—is more common than the former, for no matter what happens to the ejaculatory ducts, the power of erection usually remains if the testicles are preserved. But this is not invariable, as was shown by Civiale's[1] case of a man of 54, who became impotent after recto-vesical cystotomy, "ayant perdu la faculté d'entrer en érection."

The older writers had this complication in view in advising the lateral and para-rapheal operations rather than a deep median incision of the neck of the bladder, their object being to spare the seminal ducts. Injury was often done to these ducts, according to Ledran, in the old operation by the apparatus major, so that the semen was not ejaculated during sexual intercourse, but escaped afterwards, dribbling away or coming out upon urination. A properly directed deep incision in the lateral operation, or in the bilateral deep cut, falls outside the course of the seminal duct as it tunnels the prostate, and the testimony of all observers is of accord upon this point, that when harm is done to the seminal canals during lithotomy, its cause is to be found rather in the bruising and tearing violence exercised in extracting a large rough stone through insufficient deep incisions, than in any irregularity or excess of those excisions. A demonstration that sterility may be induced by obliteration of the vas deferens has been given by Goodhart,[2] who showed, at the Pathological Society in London, a specimen illustrating the obliteration of one vas deferens after lithotomy in a child. Malgaigne[3] saw two cases of impotence following perineal lithotomy, and Aston Key[4] one. Teevan gives also some testimony on this point,[5] recording four cases in which after lithotomy there was no emission during sexual intercourse.

Treatment in cases of sterility following lithotomy is unavailing, unless it be in a case where a permanent fistula is left behind, and the semen escapes through it. In such a case the obvious remedy is closing the fistula.

4. *Perineal Fistula.*—This disagreeable after-effect of the perineal incision has been noted quite often. It may be caused by general debility of the patient, whose vital forces do not prove sufficient to effect the closure of his wound; or by some accident, such as incrustation of the walls of the wound, detention of a fragment of stone, or some sloughing or ulceration of the wound which has followed the operation; or by the existence of a stricture in the urethra anterior to the internal orifice of the fistula. A fistula cannot be said to exist until at least six months after the operation has been performed, for nature occasionally takes this much time to close the wound.

The indications for treatment are to relieve stricture, if it exists, and by diluents and local treatment of the bladder to purify the urine, should the latter be ammoniacal. Then the expedients may be resorted to of passing the catheter for each act of urination, or making pressure upon the fistula during each natural urinary act. Failing in these measures, the fistula should have its external orifice enlarged, and its track scraped so that the pyogenic membrane may be removed and the healing process stimulated; or the track of the fistula may be freshened into activity by passing into it at intervals a probe dipped in nitric acid or with a bit of nitrate of silver fused upon its tip. Finally, other means failing, the fistula may be cut down upon and its sides dissected out, the freshened surfaces being kept together and the catheter passed to draw away the urine. In some cases all efforts fail, and a permanent fistula results.

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[1] Op. cit., p. 579. Paris, 1838.

[2] Trans. Path. Soc Lond., 1876.

[3] Journ. de Méd., Chir., et Pharm., t. xx. p. 548. 1855.

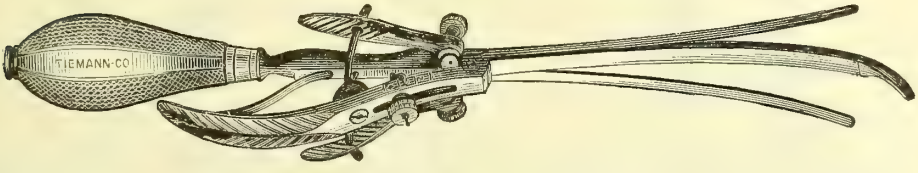
[4] Guy's Hosp. Reports, 1st series, vol. ii. p. 26. 1837.

[5] Trans. Clin. Soc. Lond., vol. vii. 1874, pp. 179, 180.

II. Bilateral Lithotomy.—The bilateral operation of Dupuytren, suitable for the extraction of large stones by the perineum, is performed as follows: The patient is fixed in the ordinary lithotomy position, and the staff, having a median groove, is held centrally. A semi-lunar incision is made crossing the raphe, about one inch (from 22 to 24 millimetres) in front of the anus. The integument, cellular tissue, and anterior fibres of the sphincter are cut. The left index finger is now introduced into the wound and made to depress the rectum, while with short strokes of the knife the surgeon endeavors to free those muscular fibres, a part of the sphincter, which hold the bulb of the urethra attached to the anus. The bulb is now turned up and the finger seeks the membranous urethra far back in the wound. This is to be opened upon the nail, the knife being held transversely, to insure safety to the rectum.

The operator now takes the double lithotome caché (Fig. 1267), enters its point in the groove of the staff, holding the instrument's convexity upwards. As soon as the lithotome is in the bladder the staff is removed, the blades of the lithotome are protruded, and the instrument is withdrawn, at first horizontally, and then with the handle slightly lowered so as to spare the rectum. As soon as the prostate has been cut through the blades are returned to their sheaths, and the lithotome is withdrawn.

Fig. 1267.



Dupuytren's double lithotome caché.

The operation of the late James R. Wood, of New York, is essentially a pre-rectal, bilateral operation. After the incision is made across the perineum in front of the rectum, and the urethra opened, the cutting part of the operation is terminated by placing the button of the bisector (Fig. 1268) in the central groove of the staff. This button is so arranged that the bisector cannot escape after its button has once entered the groove. It is pushed directly onwards into the bladder, cutting the prostate and the vesical neck to a moderate extent transversely. Dilatation does the rest.

The stone is extracted in the manner described when speaking of the lateral operation.

III. Median Lithotomy.—The median operation is suitable only for small stones. The staff should have a broad, deep, median groove. The external incision is generally made from without inwards, although most American surgeons prefer the manœuvre of Allarton,[1] who passes the left index finger into the rectum, and steadies the staff with the point of his finger pressed against it at the apex of the prostate. A stiff-backed, straight bistoury, with double cutting point, is then entered into the raphe half an inch in front of the anus and carried directly inwards, aiming for the groove in the staff at the point where it is steadied by the finger in the rectum. The groove is entered at this point, and the apex of the prostate slightly incised. The membranous urethra is cut through as the knife is being withdrawn, and the external wound is enlarged by the same motion, cutting upwards to an extent deemed sufficient for the extraction of the stone. An effort is usually made, by varying the direction of the handle during this manœuvre of withdrawing the blade of the knife, to pass beneath and around the bulb, the

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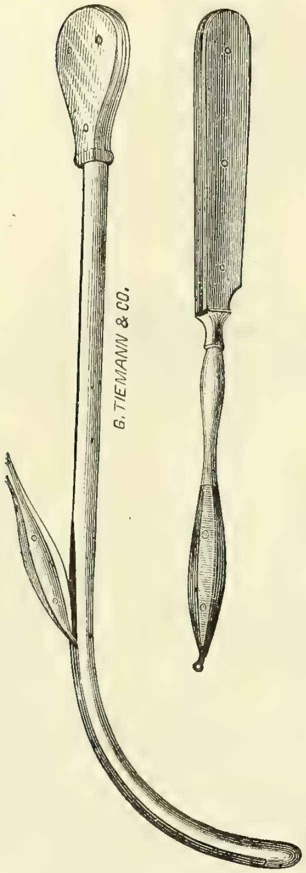
[1] A Treatise on Median Lithotomy. London, 1863.

Fig. 1268.



Wood's bisector.

Fig. 1269.

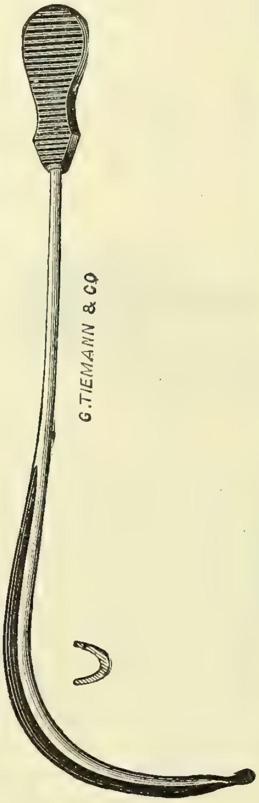
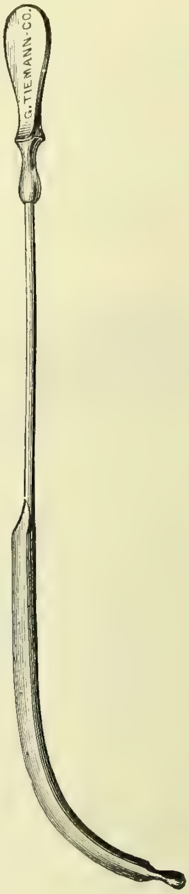


Fig. 1270.



Staff for median lithotomy.

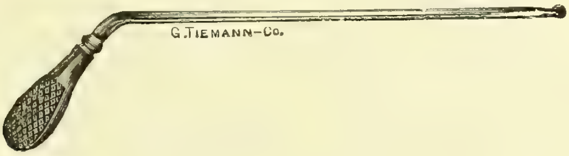
handle of the knife pointing nearly directly downwards while the membranous urethra is being incised, after which it is swept sharply around, looking nearly upwards as the incision in the raphe is being completed.

Many surgeons prefer to reach the membranous urethra in a different manner, as follows: With the left index and thumb on either side of the raphe, stretching the skin, the surgeon commences his incision with a big-bellied scalpel upon the raphe at about one and one-half inches in front of the anus, and cuts directly downwards to within one-third of an inch of the latter. The skin, cellular tissue, and superficial perineal fascia are divided until the operator comes upon the raphe uniting the lateral halves of the accelerator urinæ muscle. Following this backwards, the fibres of the sphincter ani are encountered, and may be distinguished by the fact that they are not possessed of any median raphe. These are cut transversely, and the bulb, now exposed, is turned upwards out of harm's way. This method is particularly suitable to the case of old men, in whom the bulb, much enlarged, sags downwards almost upon the rectum, and is very liable to be cut if a puncture is resorted to as in Allarton's method.

The left index is now passed into the wound behind the bulb, and made to search for the groove in the staff. The nail is there inserted, and upon this as a guide the membranous urethra is opened in the median line, and incised up to and into the apex of the prostate. The nail of the left index is maintained in its position until the right index or a director has entered the urethra, as otherwise the opening in the latter may be hard to find.

The right index finger is now gently inserted along the staff into the bladder, dilating its neck, or, in the case of children, a straight director such as Little's (Fig. 1271) is passed into the bladder, the staff is withdrawn, and along the narrow director the finger and afterwards the forceps are carried into the organ. In this way the accident of lateral rupture of the urethra by the surgeon's finger may be avoided.

Fig. 1271.



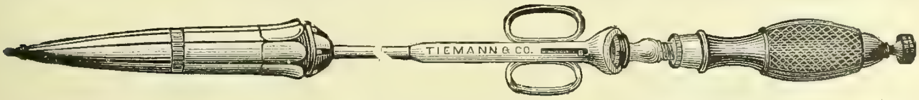
Little's lithotomy director.

After the neck of the bladder has been properly dilated by the finger, small straight forceps are introduced, and the stone is withdrawn. Recovery is rapid if the neck of the bladder has not been bruised in attempting to extract a large stone, one not suitable for the median method.

The *medio-lateral* and *medio-bilateral* methods combine an external median opening with internal, liberating, prostatic incisions on one or both sides.

Dolbeau's *perineal lithotrity* is an operation now practically obsolete even in France, the land of its birth. It may still be used successfully when the surgeon wishes to attempt to remove a large stone by the median method. The incisions up to the apex of the prostate are made from without inwards, as in the median operation. A special dilator (Fig. 1272) is then introduced along the staff into the neck of the bladder, and the latter is gradually enlarged up to the maximum point in the adult, which Dolbeau decided to be just short of one inch in diameter (24 millimetres). Up to this point the healthy neck of the adult bladder may be dilated without giving way. The crushing forceps (page 267) is now introduced, and, after fragmentation into a number of large pieces, the débris is removed with forceps, scoop, and irrigation. Great care is necessary not to damage the vesical neck in attempting to remove large angular fragments.

Fig. 1272.



Dolbeau's dilator for perineal lithotrity.

IV. Supra-pubic Lithotomy.—The best account of the modern high operation as it is now practised in Europe—notably in France—that I can find, is the description by Villeneuve[1] of what he calls the Petersen-Guyon-Périer operation. I shall borrow his description. The peculiarities of this method consist essentially in the employment of antiseptic precautions, distention of the bladder and rectum to protect the peritoneum, and vesical drainage to prevent infiltration, septicæmia, and other complications due to the faulty position of the wound; for, say what one will, the position of the wound in the high operation is a faulty one, surgically speaking.

It has been held that if the exact nature, relation, and position of the parts with the course of the bloodvessels, etc., were explained to an intelligent person who had never heard of stone in the bladder, and this person were asked what would be the best way to get the stone out, he certainly, directed by common sense, would choose the shorter and more direct route, and would try to get at the stone by cutting above the pubis.

This may be true in one sense, but the answer is equally logical. If the same nature, relation, and position of parts were explained to a modern surgeon, well versed in surgical principles, and he were required to decide by induction by what route it would be most appropriate, surgically, to extract a stone from the bladder, he would certainly choose the perineal route, notwithstanding the thickness of the tissues, since natural drainage could be best accomplished by this means.

The operation of Ferdinand Petersen is the one now generally imitated, since that surgeon's able article upon the scientific principles of the method first appeared.[2] But none of these principles, as enunciated by Petersen, are original with him, strictly speaking, although to him belongs the credit of having grouped them into an effective whole.

Asepsis in surgery had long been acknowledged as desirable wherever it could be applied. The vesical suture dates back to Rosset, in 1581, and Périer claims for France the introduction of rectal distention by a tampon as a step in the operation, saying that Milliot announced the conception of the same method in 1875, five years before Petersen, in the Medical Congress at Lyons. Milliot[3] proposed to distend the rectal tampon with air. Périer first performed the Petersen operation (somewhat modified) in France, Gosselin[4] reporting his first two cases, one of which ended fatally. Périer[5] has advocated a special form of drainage which Guyon[6] has perfected. The vesical suture is not uniformly accepted in Germany, nor generally in France. E. Bouley,[7] in his excellent monograph, collecting the cases of vesical suture from 1859 to 1881, has made a tabulated study of 23 such cases, among which failure occurred 10 times. He gives the following table:—

Catgut	used	11 times,	failed	7 times.
Carbolized silk	"	8 "	"	3 "
Ordinary thread	"	2 "	"	0 "
Metallic suture	"	2 "	"	0 "
Total		23		10

And in a general way he decides against the employment of sutures.

That the bladder may be sutured successfully is certain. Such cases have been reported by Lister, Ultzman, and others, but the tissues are very friable.

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[1] Rev. de Chirurgie, t. iii., Sept. 1883, p. 665.

[2] Ueber Sectio Alta, Langenbeck's Archiv, S. 752. 1880.

[3] Méthode opératoire par le ballonnement. Gaz. Méd. de Paris, p. 422. 1875.

[4] Bull. de l'Acad. de Méd., 2me sér., t. x. p. 1128. 1881.

[5] Bull. et Mém. de la Soc. de Chir., t. viii. p. 807.

[6] Ann. des Mal. des Organes Génito-Urinaires, Déc. 1882, et Janv. 1883.

[7] De la taille hypogastrique. Paris, 1883.

It is a different thing, in laparotomy, to turn the two peritoneal surfaces covering the bladder in upon each other and suture them effectively. This is constantly done. I know of a case in which a distinguished surgeon, having opened the abdomen in a woman for another purpose, came upon something lying in the pelvis. He was uncertain whether this something was the bladder or not, and, to decide the point, deliberately cut into the suspected tissue, and thus proved that it was the bladder. He immediately turned in the serous surfaces, and sutured them nicely; no evil result followed. T. G. Thomas,[1] of New York, in one instance, having opened the female bladder in an exploratory way for diagnostic purposes, sewed the incision into the abdominal wound with silver sutures, leaving a catheter in the bladder through the urethra; cure followed. The healthy bladder easily unites through its peritoneal coat, if this be wounded; but not so easily the soft, friable, unhealthy bladder, not covered by peritoneum at the point incised.

Trendelenburg says[2] that there can hardly be cited a case of vesical suture where, after a short time, urine has not flowed in part or wholly through the wound. The recent thesis of Garcin[3] is instructive on this point. He deals with the 94 cases of supra-pubic operation published during the years 1879–83, and says that of 20 cases of vesical suture "there were only two cases in which union by first intention occurred." Again, out of the 94 cases, there were seven in which death occurred by urinary infiltration, and "five times this accident followed vesical suture." In one of Monod's cases, in a man[4] of 63, suture was employed and a catheter left, *à demeure*, in the urethra. A small sinus only remained unhealed in the abdominal incision. This was afterwards injected with tincture of iodine to secure its closure, but fatal erysipelas followed. Juillard[5] made an accidental rent five inches long in the bladder while attempting to separate adhesions in ovariotomy. He turned in the serous surfaces, not transfixing the mucous membrane with his sutures of catgut, fifteen in number, left a catheter in the urethra, and obtained union throughout the wound. Duchastelet, one of Guyon's pupils, has proposed to go so far as to open the bladder always upon its peritoneal surface for the extraction of stone, in order to get a tougher texture and a serous surface to act upon by sutures in the effort to obtain union. Villeneuve rather inclines to join in this proposition as a possible future advance for the high operation.

Upon the subject of preliminary vesical distention, as a step in the operation, something must be said. The idea is a very old one. The bladder has been allowed to become distended by urine, the penis being ligated for a variable, sometimes a very long, time (even two days) before the operation. Air has been used as the distending agent, and water, pure or containing various substances—boracic acid, carbolic acid, etc.

But the bladder has been ruptured by even moderate distention in some cases. Monod[6] in one case fissured the bladder of a patient of 28 by injecting water—the quantity unknown—and the conclusion was reached in the discussion at the Paris Surgical Society that it was not safe to inject too much fluid, the limit being 350 grammes, a little more than eleven ounces. Petersen allows 600 grammes as the limit, 200 being the least amount. Monod's patient recovered in spite of the accident, but in a case in which Verneuil ruptured a man's bladder by injecting only 125 grammes of water, the result was death, showing that prudence places the minimum amount to be injected at a safety point inside of Petersen's 200 grammes.

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[1] Stein, Med. Record, March 17, 1883, p. 286.

[2] Berliner klinische Wochenschrift, 1881.

[3] Contribution clinique à l'étude de la cystotomie sus-pubienne, avec statistique comprenant les années 1879-1883. Strasbourg, 1884.

[4] Bull. de la Soc. de Chir., 5 Décembre, 1881, p. 758.

[5] Centralblatt für Gynäkologie, 7 Juli, 1883.

[6] Rev. de Chirurgie, No. 4, 10 Mars, 1882, p. 296.

Guyon's contribution to the Petersen-Guyon-Périer method is a special manœuvre for rolling upwards the peritoneum out of harm's way.

The high operation may be executed with the least possible apparatus: a sound, a knife, and the fingers may accomplish it. That the operation may be safely done with rude tools, is proved by the well-known case of John Doot, the smith of Amsterdam, who cut himself above the pubis in May, 1651, with a sharp shoemaker's knife, and delivered himself successfully of a large stone. It has always seemed to me probable that this operation must have been upon a stone encysted above the pubis, perhaps trying to ulcerate its own way out, or possibly upon a stone situated in a vesical hernia in the groin—but this is conjecture only.

As to drainage of the bladder, many methods have been used. At one period in the operation it was one of the regular steps to open the urethra in its membranous portion, not purposely for drainage, but for the passage of instruments in the further continuance of the operation. Yet it is notable that in many cases of a severe character the perineum has been first opened by the lateral method in the hope of extracting the foreign body, and, when the operator has failed in this direction, the bladder has been opened above the pubis, and the offending body removed, success crowning the operation. May it not have been in these serious cases that the perineal incision, instead of being a disagreeable complication, has been in reality the means of establishing efficient surgical drainage which has saved the patient? Billroth's well-known case of myomatous tumor in the bladder was one of this kind. Watson's case, referred to by Dulles, was another, and a third was a striking case of extraction of a very large stone from a boy by Dr. Howe,[1] of New York, in which the peritoneum was opened and the intestines appeared in the supra-pubic wound. There was, however, free drainage, the perineal opening was ample, and the boy recovered.

Undoubtedly all cases cut both in the perineum and at the same time above the pubis do not recover, but it is doubtful if the perineal opening can be looked upon as a damaging complication. But there are other methods of draining the bladder more surgical than the perineal incision. The plan of leaving a soft catheter in the urethra is doubtless not a good one, because its presence in the sensitive neck of the bladder excites that organ to attempts at contraction, and the catheter may slip or be forced out, or may become occluded.

As early as 1750, Palluci perforated the bas-fond of the bladder, and drained it in this manner through the perineum. Deschamps, in 1796, perforated through the bas-fond into the rectum, and brought the tube out through the anus. McBurney, of New York, did the same thing with the "convolvulus" catheter a few years ago, and I have used the same method for successfully draining the bladder. But I find in my cases that the tube, be it convolvulus or other, is apt to slip out.

The actual cautery has been used as a means of opening the bladder, as has the écraseur, and the operation has been divided between two sittings; all these plans are designed to prevent infiltration, but all have been given up. The patient has been made to assume and maintain different positions after the operation, for purposes of drainage, but to no purpose. Thus even the abdominal decubitus has been insisted upon. It is said that Trendelenburg employs it.

Monod declares that the greatest danger after this operation is from infiltration, and that it is most often due to tearing away the cellular attachments of the bladder from the pubis. Evidently a clean incision without tearing, and thorough drainage, are the proper means to employ to prevent infiltration.

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[1] Reported to the New York Pathological and to the New York Surgical Societies in 1883.

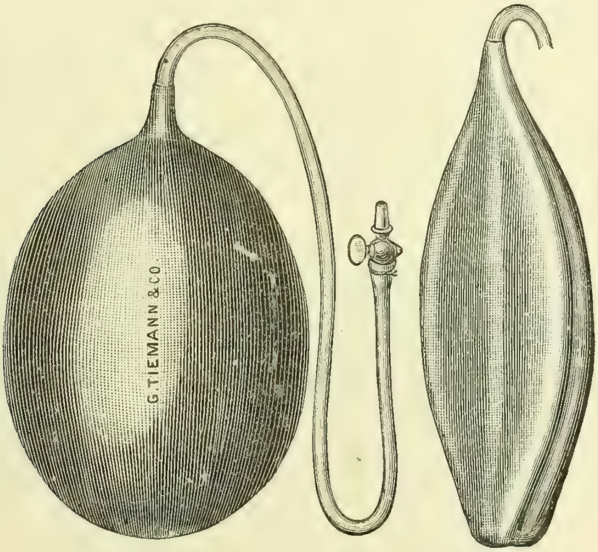
The following is a description of the Petersen-Guyon-Périer method as described by Villeneuve:—

Mode of Performing the High Operation.—All hair is to be shaved from the pubis, the parts are to be washed in an antiseptic solution (carbolic acid 1 in 20, or bichloride of mercury 1 in 1000), and all the details of antiseptic surgery are to be carried out. Anæsthesia is pushed to complete relaxation. A silver catheter with stopcock is introduced. The bladder is emptied and washed clean with a four-per-cent. solution of boracic acid. When the wash returns clean, the bladder is slowly distended with the same solution and the stopcock turned; meantime the penis has been tied over the silver catheter with a rubber tube, the tension of which is maintained by a forcipressure forceps.

The amount of fluid varies with the receptivity and the degree of irritability and resistance of the bladder. If too much be thrown in, there is danger of rupturing the organ, an accident which has occurred in able hands (Monod, Cheselden, Verneuil). Two hundred grammes (between six and seven ounces) is considered a moderate amount, and six hundred grammes the limit. A piston syringe is used, and a guide to the amount to be thrown in is stated to be the resistance offered by the pressure within the bladder to the surgeon's hand as he depresses the piston—a degree of resistance to be learned by experience. It is undoubtedly wiser here to err on the side of safety. Guyon believes that an irritable condition of the bladder, not tolerating distention, contraindicates the operation.

The rubber ball (Fig. 1273) is next to be greased and inserted into the rectum. It is an ordinary colpeurynter—Guyon insists that it should be made of stiff, thick rubber, so as to be hard and tense when distended—and through its tube from twelve to twenty ounces of warm water are to be injected. Six hundred grammes is said to be about the proper amount, but undoubt-

Fig. 1273.


G. TIEMANN & CO.

Rectal colpeurynter, one-half natural size; distended, and collapsed for introduction.

edly this quantity must vary in different cases. The distention of the rectum brings the bladder plainly into view above the pubis.

An incision is now made exactly in the middle line, three or four inches long, stopping at the pubic symphysis. The deep fascia is incised upon a director over the entire length of the superficial cut, and the sulcus between the recti muscles is sought. If the pyramidales are in the way, the muscular fibres are to be cut directly through in the middle line. No tearing or pulling asunder is allowable, such separation of the elements of the muscle favoring infiltration. The incision must be as clean as possible.

After getting through the muscle, a yellow layer of fat is exposed, covered by the transversalis fascia. This thin fascia is seized with forceps in the middle line, near the lower angle of the wound, a button-hole incision is made, and the left forefinger is introduced, pulp upwards. The forefinger thus placed now pushes upwards the yellow layer of fat, carrying before it the peritoneal cul-de-sac. This is Guyon's manœuvre. He says that by practising it the peritoneum is never seen. The cellulo-adipose layer, between the bladder and pubis, is not to be disturbed at all, and no effort is made to reach the neck of the bladder low down in front. Such unnecessary burrowing with the finger behind the bone invites infiltration. The finger which has pushed up the fat and the peritoneum is maintained in position in the upper angle, and serves as a guide to the point of the bistoury, which is made to puncture the bladder at this point, and to continue the incision downwards in the middle line from one and a quarter to one and three-quarters inches, according to the size of the calculus. A tenaculum, or the old-fashioned hooked gorget, or any suitable blunt hook, might be used here to hold up the upper angle of the wound in the bladder. Villeneuve and Guyon make no mention of the need of any such contrivance, saying that the finger follows the bistoury into the bladder and at once finds the stone.[1]

In making the incision into the distended bladder, no attention is to be paid to a plexus of prominent veins which are seen over the front wall of the organ, and which may lie directly in the line of the proposed incision. It tears the tissues to attempt to ligate them. They are to be cleanly cut through. The hemorrhage, sometimes considerable at first, becomes arrested as the bladder collapses. If no veins are seen, Petersen's manœuvre may be adopted, cutting slowly into the muscular layers of the bladder until the mucous membrane projects through the lips of the vesical wound, then seizing the latter and incising it.

The liquid having run out, the next step is to untie the penis and remove the catheter. As this is being done the finger of the surgeon follows the bistoury into the bladder, detects the stone and places it in a position favorable for removal. The forceps follow the finger, seize the stone, and extract it slowly, and with care not to bruise the sides of the vesical incision. If the latter be too small it should be enlarged toward the neck of the bladder with a probe-pointed bistoury, as the stone is held in the forceps. All the stones having been extracted, and any débris or clot removed, the bladder is to be carefully washed with the boracic-acid solution and the rectal tampon withdrawn.

Two large parallel tubes of soft red rubber, fenestrated only at their extremity, are now to be introduced upon the finger to the bottom of the bladder near the vesical neck. These tubes must be long enough to mount over the pubes and enter a urinal placed in the bed between the patient's thighs. The tubes are united together by silver wire, passed through their walls, but not into their cavity, and are attached superficially to the lips of the wound by a point of superficial suture on either side.

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[1] Since this article has been in type, I learn that Guyon now has the lips of the vesical wound held apart by loops of silk ligature inserted on either side. (Annales de Dermatologie et de Syphiligraphie, Nov. 1885.)

The wound itself is closed in its upper third, the sutures being passed through the skin, superficial fascia, and borders of the recti muscles, without touching the bladder or the peritoneum. A few points of superficial suture are required, and a Lister dressing, or a bichloride or iodoform antiseptic pad is applied, the dressing being perforated for the passage of the tubes. Guyon says that he has been able to wash the bladder through one of these tubes, the flow returning through the other without wetting the dressing.

During the period of after-treatment the dressing is removed two or three times and reapplied. The tubes are taken out at the end of a week, and intermittent catheterization by the urethra is then resorted to. Drainage by this method is said to be admirable, and the cure is said to be complete by the twentieth day.

Complications.—The complications and accidents peculiar to supra-pubic lithotomy are three: Rupture of the bladder during preliminary distention, infiltration of the wound from bad drainage, and wounding the peritoneum.

The first two of these complications have already been sufficiently considered. Wounds of the peritoneum have been recorded at the hands of excellent operators (Douglas, Thornhill, Frère Côme, Souberbielle, and others). Among the 478 cases collated by Dulles it occurred as a complication 13 times, but only once with a fatal result. In Howe's case, to which I have alluded, the peritoneum was opened without any evil effect. Petersen, who, in 1878, made 14 experiments with his method upon the dead subject, never even saw the peritoneum during the operation, and in the 21 cases of the Petersen method published in France, this accident has not occurred. If the peritoneum should be wounded, and the bowel exposed, a flat sponge, wrung out of a warm antiseptic solution, should be placed over the upper angle of the wound until the operation is over, and then the peritoneal rent should be united by a very fine, continuous, catgut suture, which in its turn should be buried in the healthy tissues united above it by deep sutures from without.

Infiltration is usually fatal, but not necessarily so. It is to be treated on general surgical principles. Souberbielle only saw it once in 39 operations, and Dulles only mentions it 7 times in his tables of 478. The cleaner the cut, the less tearing of the tissues that occurs, and the better the drainage, the less is the chance of infiltration.

EXTRA-VESICAL LITHOTOMY.—A calculus in a fistulous tract outside of the bladder, or in a cystocele in the groin or labium, yields symptoms depending on its size and position. Each case becomes a special study if removal is called for, and must be met upon its merits. Cavities from which such calculi are removed should be scraped, and the vesical or urethral orifice of the tract should be closed, if possible. Extra-vesical *lithotrity* has been described as a formal surgical procedure, but it surely does not deserve the dignity of such designation.

URINARY CALCULUS IN THE FEMALE.

The same causes which lead to stone formation in the bladder of the male are equally active in the female, but the physical conditions in the latter are less favorable to the retention and growth of the foreign body in the case of primary acid calculus, because the short, large urethra offers an easy exit for the nucleus, while the absence of a prostate, the rarity of sacculation, and the comparative infrequence of serious vesical catarrh, are sufficient to account for the relative rarity of secondary phosphatic stone in women. Cystocele, on the other hand—a condition quite analogous to sacculation—is not uncommon in the female.

Foreign bodies as a nucleus for stone play a relatively more important part in women than in men, for obvious reasons. Gynæcologists have noticed that large stones are sometimes found in the female bladder shortly after the surgical closure of a vesico-vaginal fistula. Emmet says that he has encountered many such cases, and that he sometimes has found a small portion of silver wire to be the nucleus of such a concretion. My collection contains one stone of this character, the inference being obvious that the operator, when closing the fistula, left a fragment of silver wire in the bladder. As a rule, in such cases, Emmet[1] believes that the phosphatic nucleus of the stone forms upon some denuded portion of the cut surface which has been carelessly turned inward, and left thus when the surgeon has been adjusting the edges of the vesico-vaginal wound. Campbell,[2] of Georgia, has taken the ground that stone may often exist within the bladder at the moment of operation for fistula, and escape the notice of the surgeon, being held up and out of the way, concealed in the folds of the bladder, by partial vesical contraction, and coming down into the vesical cavity after the latter has been formed by an obliteration of the vaginal fistula.

The relative frequency of stone in women is generally estimated at about 1 in 20 as compared with the male. In the Norwich collection (Crosse) 669 stones came from males, 35 from females, or 1 in 19. Civiale's[3] statistics from the Hôtel-Dieu show that, between 1808 and 1830, out of 284 operations for stone, 17 were upon females, a ratio of 1 in 16. Again, Civiale shows that in 1104 cases in Italy, the ratio of females to males was 1 in 18, and in France among 2834 operations 1 in 22. South,[4] in a table of operations at St. Thomas's Hospital from 1822 to 1845, gives only two as occurring in females among 144 cases, 1 in 72. Coulson[5] has shown that out of 2834 patients, 123 were females, 1 in 23. Prout gives the same number in his estimate. Kline is quoted by Coulson as making the proportion in the Moscow City Hospital, from 1822 to 1860, much lower—1792 cases, of which 4 were in females, 1 in 448.

The symptoms of stone in the bladder in the female are similar to those observed in the male—namely, those of cystitis and vesical irritation; frequent urination, often with blood; much tenesmus; bearing-down, dragging pains in the lower belly, groins, loins, and back, sometimes streaming down the thighs; and, not infrequently, incontinence of urine. All these symptoms are aggravated by exercise, and are subject to periods of exacerbation. The symptoms sometimes simulate those of uterine disease, but physical exploration clears up the doubt.

Retention of urine in the female may be caused by impaction of stone in the urethra.

The diagnosis of stone in the female is easier than in the male. A finger in the vagina greatly facilitates the search, and a short, curved, or straight steel sound usually strikes the foreign body at once. In case of grave doubt, where a small stone is encysted or in an out-of-the-way position, it is entirely justifiable to administer ether, and, dilating the urethra, to explore the whole of the interior of the bladder with the finger. In one case,

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[1] Principles and Practice of Gynæcology, p. 741. 1879.

[2] Trans. Am. Gynæcol. Soc., vol. i., 1875; and Emmet, op. cit.

[3] Traité de l'Affection Calculeuse, p. 594. Paris, 1838

[4] Chelius's Surgery, vol. ii. p. 635.

[5] Lithotrity and Lithotomy, p. 247; and op cit., p. 370.

Thompson found a stone so thoroughly encysted as to be practically imbedded in the vesical walls, which had to be cut through in order to liberate the offending body.

Emmet[1] also describes a remarkable case. He detected a stone, found it always in the same place, and made out that it was detained in the ureter. By making backward pressure with a large sound in the bladder, the stone could always be felt by the finger, introduced either into the vagina or the rectum. Therefore, with the stone so held in place by a sound, a speculum was introduced into the vagina, and the stone was cut down upon with scissors, the wound being enlarged toward the neck of the bladder. In this way the calculus was removed without opening either the peritoneum or the vesical cavity. I have this stone in my collection now. It is about as large as the little finger, $1\frac{7}{8}$ inch long, $\frac{1}{2}$ inch in diameter, $4\frac{5}{8}$ inches in the long and $1\frac{1}{2}$ inch in the short circumference. Interrupted sutures were applied, and the patient did well.

From motives of delicacy, women often conceal the fact of being afflicted with vesical maladies, and this may perhaps explain why so many cases are on record where enormous stones have been passed spontaneously by the urethra, or have ulcerated their way through the vesico-vaginal septum. Coulson quotes Bouqué as saying that out of 204 collected cases of vesico-vaginal fistula, 6 were due to this cause. Agnew[2] records a personal case in which a calculus as large as a goose-egg ulcerated its way into the vagina, and in which the opening closed spontaneously without leaving a fistula behind. Gross[3] refers to Collot, Beards, Baker Brown, Middleton, Botti, Klauder, Garden, and Wilks, as having recorded cases of the spontaneous discharge of stones. the calculi varying in weight from two to twelve ounces.

Tho. Molineux[4] records the case of one Mrs. Margaret Plunkett, who expelled through the "urinary passage," without medical or surgical aid, a stone weighing ℥ij ʒij ℈j gr. vj, Troy, and having circumferences $7\frac{1}{10} \times 5\frac{3}{4}$ inches. Incontinence followed.

Another case in the Transactions is that of a "Gentlewoman of Wallingford," 63 years old, who had taken from her by her husband, without instruments and without blood, a stone having a length of $4\frac{3}{4}$ inches, and a compass of $5\frac{1}{2}$; weight ℥iij, avoirdupois. She recovered with incontinence.

Garden's case[5] is that in which four stones were passed by a woman, one of them 5×4 inches in circumference. Coulson[6] quotes from Tulpius, that a lady of 89 passed spontaneously by the urethra a stone weighing three ounces and two drachms. Guérin[7] records the case of a woman who passed in the same manner a stone as large as a pullet's egg, weighing nearly an ounce. This she did without any surgical aid, four days before confinement.

Incontinence of urine, generally permanent, has been found to follow the expulsion of the stone in these cases.

Yelloly[8] records the case of a woman from whose urethra there was extracted without operation a stone weighing 3 ounces $3\frac{1}{2}$ drachms, Troy; $3\frac{1}{8}$ inches long, 2 broad, $1\frac{7}{8}$ thick; $7\frac{3}{4} \times 5\frac{1}{2}$ inches in circumference. Incontinence followed. I have found the record of another case, in a woman of 80, who passed a stone weighing 40 grammes, 5 inches in circumference. Incontinence followed at first, but after twenty days this venerable dame could hold her urine for more than an hour. She had passed 453 stones previously.

These instances go to show that this malady does not necessarily shorten life in the female. Finally, as showing how large a stone may be extracted surgically without causing incontinence, may be instanced a case recorded by W. F. Atlee.[1]

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[1] Op. cit., p. 754.

[2] Op. cit., vol. ii. p. 693.

[3] Urinary Organs, p. 300. 1876.

[4] Philosophical Transactions, abridged, etc., 4th ed., 1731. Obs. 66, p. 151.

[5] Ibid., Obs. 61, p. 150.

[6] Op. cit., p. 370.

[7] Journal de Méd., Chir., Pharm., etc., t. xxxi. p. 162. Paris, 1769.

[8] Med.-Chir. Trans., vol. vi. p. 574. London, 1819.

The patient was an old woman of 73; the urethra was rapidly dilated, and a hard stone weighing 220 grains, $3\frac{1}{10} \times 2\frac{9}{10}$ inches in circumference, was extracted; no incontinence of urine followed.

Stone in the female bladder may prove an obstacle to parturition. Life, two lives at once, have been sacrificed from this cause.

Threlfall[2] records a case where the existence of stone was not suspected before labor commenced, nor diagnosticated until after death, when the calculus was removed and found to weigh 6 ounces 5 drachms 34 grains, and to be $3\frac{5}{8}$ inches long, $2\frac{7}{8}$ broad, $2\frac{1}{4}$ thick. A more fortunate case, quoted by Poland[3] from Velpeau, is one in which a stone weighing $9\frac{1}{2}$ ounces was extracted from a woman in the fourth month of pregnancy with a successful result, the woman going on afterwards to a happy deliverance at term.

Hugenberger's[4] collection of twenty-three cases of calculus occurring during pregnancy is very instructive. In four of these the stone was removed during the early months of pregnancy. In seven the patient passed the stone spontaneously, often with serious after-effect. Coulson[5] records a personal case in which the stone had a hair-pin for a nucleus. The stone was raised above the pubis, and the labor continued favorably. Two months afterwards the stone was removed by lithotrity and the hair-pin extracted. In Monod's[6] case, vaginal lithotomy was performed after labor had commenced, and the woman was then delivered with forceps. Erichsen[7] cites a case in which a large stone prevented parturition and necessitated craniotomy. Craniotomy was also resorted to in Threlfall's case, already alluded to.

The obvious course to pursue when stone complicates pregnancy, is to remove the calculus at the earliest possible period. If its existence is not made out until labor sets in, the stone should, if possible, be pushed above the brim of the pelvis, out of the way of the fœtal head; such a course has the sanction of high authority (Smellie, Dubois, and others). If this cannot be done, the offending body must be removed, preferably by vaginal cystotomy.

Treatment of Stone in the Female.—Cutting on the stone, the latter being seized by a finger passed above it through the vagina or (in a virgin) through the rectum, was the method first advised by Celsus, Rhazes, Albucasis, and sometimes by Paré, practised with disastrous results by Frère Jacques, and soon abandoned as an unsurgical and deadly method. Marianus Sanctus, Collot, and others advocated urethral cystotomy. After this may be mentioned the French vestibular operation devised by Lisfranc, which was very rarely practised, and which has been uniformly condemned; and then the various operations of incising the urethra, dilating the urethra, lithotrity, vesico-vaginal lithotomy, and the supra-pubic section.

At the present day but three methods retain a position of general approval, namely, (1) dilatation of the urethra for small stones, (2) litholapaxy for larger ones, unless it is desired to drain the bladder subsequently in the case of phosphatic calculi, when (3) vesico-vaginal lithotomy is the favorite.

A few words will suffice to dispose of the other methods, before taking up these three operations of choice.

Urethral Lithotomy.—The urethra has been cut below, above, laterally, bilaterally, through a part or through its entire length, and sometimes into the neck of the bladder. Generally this method is combined with dilatation of the neck of the bladder, and the wound is sutured afterwards, a soft or sometimes a Sims's hard catheter being left in the bladder for several days. The objection to this method is that it is wholly unnecessary. Any stone that can be taken out by slightly cutting the urethra, may be more easily removed by litholapaxy with less dilatation of the urethra. If the calculus is so large that the urethral incision must extend into the neck of the bladder, there is great danger of permanent incontinence, and an incision through the vesico-vaginal septum is preferable and less likely to be followed by a failure of the wound to heal, while if vesico-vaginal fistula does unexpectedly result, its subsequent closure is a comparatively simple matter.

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[1] Trans. Coll. Phys. Phila,, N. S., vol. iv. p. 368.

[2] Edinburgh Med. and Surg. Journ., vol. xxxi. p. 56. 1829.

[3] Art. Urinary Calculi and Lithotomy. Holmes's System of Surgery, 2d edit., vol. iv. p. 1090.

[4] Volkmann's Sammlung klinischer Vorträge, No. 88, S. 660.

[5] Op. cit., p. 517.

[6] Med. Times and Gaz., vol. i. p. 356. 1858.

[7] Referred to by Coulson (op. cit., p. 517).

The *supra-pubic operation* in the female is also not often called for. Its mortality, statistically, is less than in the male subject, a little more than 12 per cent. as compared with about 30 per cent. In the case of very large stones and of certain foreign bodies, perhaps in some cases of encysted stone, and possibly in very young children with small vaginæ, the high operation might be chosen with advantage. In such cases the Petersen-Guyon-Périer operation already described (page 291) would be applicable, substituting a thin rubber bag inserted into the bladder through the urethra (Milliot's method), and there inflated, in place of the vesical injection, and draining afterwards by a tube passed through the floor of the bladder and out by the vagina, instead of by two tubes through the abdominal incision, irrigation being practised through a catheter passed at stated intervals through the urethra. There remain to be considered urethral dilatation, litholapaxy, and vesico-vaginal lithotomy.

Urethral Dilatation.—Franco proposed the use of a dilator, but found that when the muscular fibres of the urethra were torn, permanent incontinence was likely to ensue. The introduction of anæsthesia has made safe dilatation more possible, and this method, as applied to the extraction of small stones less than half an inch in their smallest diameter, is entirely suitable for use at the present day. Bryant places the limit of size at which a stone may be safely extracted by dilatation, at a circumference of two inches.

Various instruments and methods have been devised for the purpose of dilating the urethral canal, some acting rapidly, some slowly. Sponge-tents, water-pressure, and all means of slow dilatation have fallen into disuse. At present it is customary to employ a two-bladed or three-bladed forceps and the fingers, commencing with the little finger. I have found the most convenient instrument to be the dilator of Dolbeau (page 287). By introducing the different sizes of this dilator, it becomes presently very possible to introduce the finger without force, and then with a narrow-bladed forceps to extract the stone. I have never dilated the female urethra to a size larger than three-fourths of an inch in diameter. This I have done a number of times for the extraction of stone and for other purposes, and I have not yet met with any case of incontinence of urine as a result either temporary or permanent. The method seems an excellent one when the stone is quite small. No after-treatment other than rest for a few days, and the administration of a urinary diluent, is called for.

Either *litholapaxy*, or *ordinary lithotrity*, may be employed in the female with great ease and safety. The former is applicable to all cases in which the stone can be grasped and fractured by the crushing instrument. No stone is too small for it, and it might perhaps be adopted with advantage even in cases where the stone was so small that it could be safely extracted through the dilated urethra. The only cases unsuited for this operation are, where the stone is encysted, where the nucleus is some foreign body which cannot be safely removed by crushing and washing out the fragments, where the stone is so large that it cannot be seized, or so hard that it cannot be crushed after having been caught, and, finally, where the bladder is very irritable, much inflamed or ulcerated, or contains a tumor as well as a stone, and where it is deemed wiser to leave the organ totally at rest after the operation. In such cases vaginal cystotomy is preferable to litholapaxy. Sometimes in connection with stone there is incontinence of urine, and water thrown into the bladder immediately returns through the urethra. In such a case, if the bladder does not become more passive under profound anæsthesia, the operation may still be safely performed with a small smooth lithotrite and a straight tube for washing. I have operated successfully upon female subjects at both extremes of life, in a child of four years and in an old lady past sixty.

The operative manœuvres are the same as in the male, but much simpler. A finger in the vagina may greatly aid the operator. The straight tube gives the most effective return to the washing bottle, but a curved tube may be used. The female urethra is so easily dilatable that a very large tube will pass. The after-care involves rest, and perhaps vesical irrigation, with the administration of a little anodyne for a few days.

Vaginal Lithotomy.—This operation is at present a favorite one for the extraction of stone from the female bladder, in those cases which cannot be dealt with by litholapaxy. The dependent opening can be made amply large, the bladder is drained through it effectively, the operation is safe and successful. The mortality, according to Aveling's[1] statistics collected in 1864, is about 3 per cent.—1 out of 35 cases. Vidal had 30 cases without a death, but he complained that fistula often followed. Agnew[2] credits 48 operations to American surgeons with two deaths. In both these cases the stone was very large. Rousset appears to have been the first to devise and perform the operation near the end of the sixteenth century. Fabricius Hildanus followed in the seventeenth. Bussière, in 1699, took out by this method a stone weighing five ounces and a half. Méry, in 1700, described the operation, and many others followed, but the fear of permanent vesico-vaginal fistula caused it to be received with caution, and to be absolutely rejected by many surgeons. According to Velpeau, permanent fistula remains in one case out of every four operated upon.

In order to overcome this tendency to persistent fistula, attempts have been made to effect immediate closure of the wound, and a number of successes have been recorded, so that this method has with many come to be looked upon as a good one. This position is, however, not accepted by American gynæcologists of the present day. Emmet says that the vesical wound heals promptly after incision, if the bladder be irrigated and if incrustation of the cut edges with ammonio-magnesian deposits be prevented. He takes the ground that the wound is liable to close too promptly for the good of the bladder, that is, before the chronic inflammation has subsided, and he has recently devised a means of retaining the incision permanently open until it is the will of the surgeon to close it. This means[3] is the attachment of the mucous membrane of the bladder to that of the vagina, along the entire length of the incision on both sides, by points of fine suture. In this way healing becomes impossible, and the vesico-vaginal fistula remains until the bladder has recovered, after which it is closed by the usual method.

In speaking of this operation, Emmet[4] gives to Sims the credit of suggesting the propriety of opening the floor of the bladder in the female for the relief of chronic cystitis. The operation is performed with the patient lying in the Sims position on the left side, with the shoulders low, the hips elevated, the thighs and legs flexed. The vagina is held open by a speculum in the hands of an assistant. A sound with a short curve is introduced into the urethra and turned backwards, so that its tip sharply depresses the floor of the bladder near its neck.

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[1] Obstetrical Transactions, vol. v. 1864.

[2] Op cit., vol. ii. p. 695.

[3] Oral communication.

[4] Principles and Practice of Gynæcology, p. 728. 1879.

A tenaculum is used to steady the parts, and this tip is cut down upon boldly, so that the wound may penetrate the vaginal and the vesical wall at the same site. Scissors are introduced into this button-hole, and an incision is made directly upwards, an inch if necessary, or a little more. Through such an incision a large stone may be removed. If it prove too large, it may be crushed with some of the powerful instruments employed for the male, and the fragments removed separately.

The patient is next placed upon her back with a bed-pan beneath her. The small nozzle of a Davidson's syringe is passed into the urethra, the vagina held open with two fingers, and copious irrigation practised until all fragments, blood-clot, etc., have been removed. If the bladder is found healthy, the wound is brought together at once with silver sutures, and the case is treated exactly like one of operation for vesico-vaginal fistula. If the bladder is not healthy, it is irrigated twice daily, and the wound is kept open by the daily introduction of a sound separating its edges, or, as Emmet now advises and practises, by attaching the vesical to the vaginal mucous membrane along the entire length of the wound on both sides. A silver suture, properly applied and twisted, will arrest any hemorrhage.

In order to keep the wound from closing too rapidly, Pallen advises that the incision should be made with the Paquelin thermo-cautery, but Emmet does not sanction this modification.

Emmet narrates a case in which, by opening the floor of the bladder, he was on one occasion enabled to detect a stone fixed in the mouth of one of the ureters, and to remove it easily by means of a narrow pair of curette forceps.

EXPLANATION OF PLATE ILLUSTRATING THE APPEARANCE OF SOME OF THE FORMS OF URINARY CALCULUS.

FIG. 1. Alternating calculus; showing on section multiple nucleus of oxalate of lime, waving lines of oxalate-of-lime formation surrounding the nuclei, then alternating layers of uric acid, urate of ammonium, oxalate of lime, and phosphates, succeeding each other. Natural size.

From the collection of Van Buren and Keyes.

FIG. 2. Uric-acid calculus, natural size, showing on section concentric lamination about the nucleus of uric acid, waving lines of oxalate of lime, and radiate structure of uric acid beyond.

From the collection of Van Buren and Keyes.

FIG. 3. Mulberry calculus, natural size. Oxalate of lime.

From the collection of Van Buren and Keyes.

FIG. 4. Kidney-stone of xanthic oxide now in Army Medical Museum, Washington. Described by Dr. G. L. Porter, Bridgeport, Conn., in the New England Medical Monthly, May, 1882.

FIG. 5. Kidney-stone of cystine, in the possession of Dr. Robt. F. Weir, of New York.

FIGS. 6, 7. Mixed phosphatic calculi, showing formation on foreign body (bit of althea root) and excentric position of nucleus. Both stones natural size.

From the collection of Van Buren and Keyes.

LITHOTRITY.

BY

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The operation for the removal of stone in the bladder has always been considered one of the most dangerous of surgical procedures, as it is at the same time one of the most ancient. No surgical disease has given rise to more discussion, none to more controversy; and not alone in modern times, for Hippocrates dwells lengthily upon the disease and the means of its remedy; and so hazardous was any attempt at the removal of stone considered, that those who practised it were of that migratory class which deemed it inadvisable to remain long in one place, while the Father of Medicine himself considered the operation so critical, or so unworthy, or both, that he made his pupils solemnly affirm that they would never attempt it. If history is to be believed, there was a seeming necessity for this affirmation in the fact that Tryphon, the usurper, induced a lithotomist of the time to operate, with fatal result, upon Antiochus the Sixth, for a stone which did not exist.

At a later period, Celsus and the Alexandrian school taught that stone was irremediable in persons over fifteen years of age. Then, as men grew bolder, age was less considered, but the season of the year became important, and operations for stone were performed only in spring time. At that season the subjects of vésical calculus were gathered into certain localities, where the peripatetic lithotomist would visit them; and, as a certain proportion of them would die, the operator found it convenient to be soon at a safe distance from the scene of his triumphs and of his disasters, well knowing that no amount or degree of the former could render his presence safe near the scene of the latter. And thus the operation continued to fluctuate in favor till near our own day, when the operation for stone was admitted to be one of the most brilliant and useful in surgery.

During all these centuries but three principal methods were practised to open the bladder, and to reach and remove the stone: 1, by the hypogastrium; 2, by the perineum; and 3, by the rectum. And one alone, the second, while it was the oldest, continued to be that which received the most general approval. These various methods, however, are here only mentioned, as a consideration of them does not enter into the purpose of this article.

The circumstances under which vesical calculi are formed, and the symptoms which they produce, have been fully considered in the preceding article,[1] and I shall therefore proceed at once to consider the mode of exploring a bladder which is suspected to contain stone, in order to determine whether or not a calculus is really present, and, if so, whether the case is one fitted for the operation of lithotrity.

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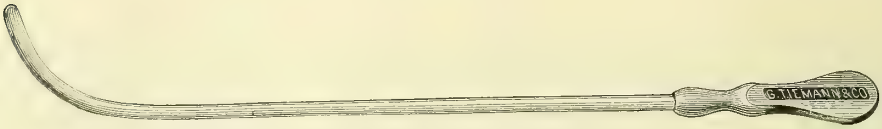
[1] See pages 149, 184, *supra*.

Instruments for Exploration.—Considerable advances have of late years been made in the construction of instruments for exploration. It may be said: 1. That the instruments must be metallic—either silver, platinum, steel, or copper; I much prefer steel. It is of small moment whether they are solid or hollow—some prefer one, some the other—but it is of much moment they should not be perforated with eyelets, nor furnished with stylets. If catheters alone are available, they should be deprived of their stylets as soon as they enter the bladder, when the urine must be retained by the thumb or index finger placed over the end. 2. Of still greater moment is the shape of the instrument. It should have a short, abrupt curve. One of the shape delineated in Fig. 1274 is the best suited for general purposes. It differs from Van Buren's in being of uniform size throughout, and from Béniqué's in not being bellied backwards at the curve—both these instruments appearing to me objectionable. The surgeon should also be provided with similar instruments of a longer curve—like that of the ordinary catheter—and corresponding to the usual curve of the urethra. Although this is different in different persons, the curve long since adopted by Paré, afterwards by Heurteloup, and more recently still by Thompson, is that which would seem to be most generally approved in America, namely, a curve equal to one-fourth the circumference of a circle three and a third inches in diameter. Usually, the stone is most easily detected with the sharp-curved instrument, but in some situations the longer curve is serviceable. 3. The size of the sound should be much under the calibre of the urethra to be examined—not so small as to permit the urine to flow away too rapidly, yet not so large as to interfere in any degree with the easy manipulation of the instrument when in the bladder.[1]

Fig. 1274.



Sound for exploring bladder.

Endoscope.—In cases of suspected stone, Cruise's endoscope has been repeatedly used, but with what advantage I have yet to learn. I have, after a fair trial commenced in 1867, discontinued its use, and I can conceive of no case in which more reliable information cannot be obtained with other means of diagnosis. In my hands it has signally failed to fulfil the expectations which I had formed regarding it. Whatever value it possesses in detecting inflamed or ulcerated spots on the lining membrane of the urethra or bladder, it has none in searching for stone; and no practical surgeon should waste his time in using it for the latter purpose when he can more readily touch than see the calculus. As much and as little may be said of the *electric lamp*, which, however, may some day aid materially in throwing light where much is sometimes needed; and the interior of the abdomen being rendered diaphanous, an opaque body, such as a calculus, may yet be found to cast or receive a shadow. This was suggested to my mind at the meeting of the International Medical Congress in Paris, seventeen years ago, but thus far no advantage has resulted as regards the detection of stone.

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[1] I have hitherto failed to recognize that relationship between the size of the urethra and the circumference of the flaccid penis which is described by Dr. Otis, and have not infrequently resorted to what Mr. Berkeley Hill claims as "the only exact mode of learning the size of a given urethra," the use of the urethrometer; I have, on the other hand, often had occasion to notice the frequent absence of the relationship referred to, and especially since the adoption of Bigelow's method has led me to use catheters of the largest size. It will, I think, be found that Dr. Otis's rule will not be found applicable in Canada, especially among French Canadians. This was well marked in two cases in which, a few years since, I operated in presence of Mr. Reginald Harrison, then in Montreal, when a small urethra was met with in a youth of large proportions, and a large urethra in another of very moderate proportions. Much more readily do I admit another statement of Dr. Otis, germane to this question, to wit, that we must recognize and respect a distinct individuality in each case, as regards the size of the normal urethra, irrespective of standards, or even of physical dimensions.

EXPLORATION OF THE BLADDER.—It is advisable that this should be done, if convenient, when the bladder is more or less full. But this is a precaution of less moment than is often believed by those who labor under the erroneous impression that the bladder is always in a state of contraction upon its contents. It is true that an exploration of all parts of the organ is not as easily made when the bladder is empty; yet, as a stone is usually met with soon after entering the bladder, its presence can generally be at once made evident. If, however, a stone be not at once detected, a more thorough examination should be deferred till the bladder is partly filled. I say *partly* filled advisedly, for examination of a *full* bladder is often more painful than is that of one but partially filled. The injection of tepid water, or of any other fluid into the bladder, as a preliminary to sounding, is an objectionable procedure, and for reasons which will be stated hereafter. If the surgeon is right-handed, let him hold the sound in his right hand; if left-handed, he should use his left hand; if ambidextrous, one or the other hand; but let him not change hands during the introduction of the instrument. This cannot be done without more or less losing of ground, and without more or less disturbance of the instrument. The left hand should merely steady the penis till the point of the instrument has entered the urethra, after which there is no use for it till the prostate is reached, and not even then in children or young adults. The practice of pushing the instrument with one hand, and drawing the penis with the other, is not to be recommended. It is no doubt very desirable that one should possess a thorough knowledge of the anatomy of the urethra and of the curves which it makes in different parts of the canal, but the best knowledge is that acquired gradually by the practice of introducing the catheter into urethræ of various dimensions and of different curves. By one possessing such experience, any arbitrary rules founded upon observation in the dissecting-room are often found to be faulty. The *tour de maître* is very brilliant, but whether the instrument is introduced with handle downwards or upwards is really of small moment. What is of great moment, however, is the *slow* introduction of the instrument—even where no difficulty would be experienced in introducing it rapidly. The instrument should also be removed slowly—a matter very strongly and very wisely insisted upon by Dr. Gouley—yet not generally attended to. When the sound is within the bladder, its convex portion—the handle being elevated—may at once be felt to strike against the stone as it lies behind the prostate and near the neck of the bladder. If not, the point should be turned to right and left, then forwards and upwards; and if not in this situation the stone will not uncommonly be felt as the instrument is being drawn back towards its first position. If still not found, the sound may be turned with its point backwards in the median line, and then to the right and left.

If felt immediately after entering the bladder, and if felt in whatever direction the sound is turned, it is reasonable to conclude that the stone is a large one. If felt sometimes on one side, sometimes on the other, and if easily displaced, its small volume may be conjectured. Its free or encysted condition may be inferred from the ease or difficulty with which, when once touched, it can be touched again. If soft and friable, the sound elicited by striking against the stone may be dull and muffled; if the "click" be a sharp one, it is usual to conjecture that the stone is hard. If, on touching it, the instrument can be sent in every other direction without feeling others, it is likely that the stone is single.

It is often found that a change in the position of the patient will facilitate the detection of stone. By some an examination in the erect posture is submitted to more readily than if lying down. It looks less formidable. It is the one I usually begin with, and, if unsatisfactory, the patient can be easily induced to assume a reclining position, or, if necessary, both in succession. On one occasion when I suspected stone, an examination in either posture was fruitless, and it was only when the patient bent forward in a *kneeling* position that the calculus could be felt. When a patient is examined in the standing posture a running conversation should be kept up to divert his attention, and also to give early intimation of dizziness, faintness, or sickness. But no patient should be allowed to pass an instrument for himself when in the erect position.[1] Sometimes, when all these methods fail with a full bladder, they may be successful with an empty or partially empty one. As the urine escapes, the instrument being just within the bladder, the calculus is drawn in against it when washed towards the urethra. When ordinary sounding fails to detect stone, it has been recommended to apply the stethoscope above the pubes while the bladder is being explored, when calculi of small size may be *heard* when they are too small to be *felt*. Another plan is to apply a sounding-board at the end of the instrument itself. In exploring for stone, however, the finger is more delicate than the ear, and the appreciation it makes of a calculus is more reliable.

Some years ago Professor Andrews, of Chicago, exhibited to the Illinois State Medical Society a stone-searcher, which utilized both the sense of hearing and that of touch. The instrument which he used consisted of a tube, hollow or solid, which was attached to an ordinary Thompson's searcher, and the free end, mounted with an ear-piece, was placed in the surgeon's ear. The suggestion is an ingenious one, but I doubt if the educated and sensitive sense of touch is much aided by this contrivance. Sand or grit which can be heard, may also be felt.

But these methods, although usually successful, are sufficiently often unsuccessful to make it our duty not to pronounce too emphatically against the existence of stone after one or two, or even several examinations, when the symptoms point in that direction. Sometimes the calculus is small and eludes detection; sometimes it lies securely imbedded in a pouch; sometimes the bladder is so dilated as to present the appearance of a second viscus; sometimes the stone lies in a kind of *cul-de-sac* of its own; sometimes, and especially in old men, the stone lies below an enlarged prostate; and sometimes it eludes detection for a time, and, when found, can be touched again at pleasure.

Desiré Bayard, aged 22, and presenting all the signs of calculus, was admitted to the Hôtel-Dieu Hospital. On introducing a sound the calculus was at once felt. Next day the patient was placed upon the operating table, and chloroform was administered preparatory to operating. The sound was again introduced, but a long and careful examination failed to establish the presence of stone. The patient was afterwards brought into the operating theatre several times, and examined by myself, and also by the late Dr. Munro, the senior surgeon, whose surgical experience was perhaps not exceeded on this continent. We examined the patient when sitting, standing, and lying, and when prone and supine, with instruments of every degree of curvature, but the desired "click" was neither heard nor felt. Three weeks elapsed in this way when, examining him in bed, I caused him to kneel and bend forward upon his hands, when the characteristic click was elicited. The stone was lying below, and in front of the prostate. I turned it back with the short curved sound, and with Civiale's lithotrite seized it, and in six sittings reduced it to fragments. The stone was of uric acid, and the débris weighed more than an ounce and a half.

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[1] The members of the profession in Montreal will remember the sad result to one of the most distinguished of their body, in the prime of life, of an attempt of the kind. Before the metallic instrument had reached the bladder, he fainted and fell forwards upon it. Severe injury of the urethra was caused, with extravasation of urine, gangrene, and death.

Sometimes an interposed membrane effectually prevents the recognition of stone. Scattered through the literature of the subject the details of numerous such cases are met with. When, however, many pouches are said to have existed in the same patient, each one hiding a stone and no part of the surface of the calculus being uncovered, I am inclined to think that possibly the instrument used may not have possessed the proper curve.

If, on the one hand, calculi may sometimes exist in the bladder and yet defy detection, there are, on the other hand, certain conditions of the urinary apparatus which give rise to the belief that calculi are present when they are not. There is scarcely a surgeon who has not felt the instrument striking against what he has erroneously considered to be a stone; and numerous have been the operations for the removal of stone where no stone existed. I shall mention these sources of error in the order of their frequence: (1) an uneven, irregular condition of the lining membrane of the bladder; (2) the folding of that membrane; (3) its roughened condition, as if sanded; (4) without any morbid condition of the bladder, the sudden jolting movement often experienced in turning the point of the sound quickly from the middle line to either right or left; (5) polypoid, fibrous, or scirrhous masses, attached or free in any part of the bladder; (6) bony or other tumors of the pubis, sacrum, or ischium; (7) the striking of the handle of the instrument against a button on the patient's or surgeon's clothing; (8) indurated feces in the rectum; and (9) in females, a misplaced uterus or ovary. These, and other sources of error, are sufficiently numerous to make it desirable not to be satisfied with once striking the calculus. A second and a third touch are advisable.

A distinguished Canadian surgeon, now dead, once fancied that he detected stone in the bladder of a young child who presented the usual signs of calculus. Lithotomy was decided upon. Of those present at the operation a select few *felt* the click; the others politely *heard* it; but when the bladder was cut into no stone was found. Fortunately for the surgeon, the child's condition was improved by the operation, and nothing disagreeable grew out of it.

Brodie, Cloquet, Houstel, Velpeau, and many others in Europe have related somewhat similar experiences.

Not only must the presence of a calculus be clearly made out, but its size, form, density, position, etc., must also be determined, and whether it is free or encysted. These are matters of interest to the lithotomist, who cuts for all calculi, hard and soft, large and small, encysted and free; but to the lithotritist, who selects his cases, they are of much greater moment. If the stone is not easily found, and if it is not easily refound; if, moreover, it moves on the slightest contact with the instrument, it is reasonable to infer that it is a small one, and that it is free. But if we meet it in all directions, and if the sound strikes it in some way in all positions as we enter the bladder, we have reason to conclude that the stone is large. Its approximate size may be determined by the sound alone, made to travel in all directions over its surface; but its exact volume can only be made out by measurement, and the lithotrite is perhaps the most convenient instrument for the purpose.

The density of a stone may be approximately established by the sense of touch, and by the sound elicited when it is struck—the soft, friable stone usually giving out a comparatively dull sound, and the hard stone a sharp sound. But operators would fall into frequent error were they guided solely by the sense of touch or of hearing in deciding upon the density or hardness of a calculus. I have more than once elicited a very sharp, ringing sound from a soft stone; and a dull sound from a hard one. The clearness of sound not unfrequently depends upon the slight extent of contact of the calculus with the surface of the mucous membrane of the bladder; and the dulness upon the more extensive contact whereby the bladder partially envelops it and muffles the sound. Clearness or dulness often depends upon the ease and quickness with which the stone can be struck. With an instrument which completely fills the urethra, and which has its movements somewhat impeded in consequence, the sound will not be as clear as when the stone is struck quickly, sharply, lightly, and with freedom, by an instrument not so held. Moreover, the note elicited may be dull or clear according to the part of the instrument with which the stone is struck: when with the point, the sound is clearer when struck laterally than when directly; and laterally or directly, the sound is clearer than when struck by the instrument at a distance from the point. In a word, it must be borne in mind that the sound produced by striking the stone is not solely dependent upon its size, hardness, or density, but is much modified by the condition of the containing viscus and the canal which leads to it, the instrument which impinges on it, and the hand by which this is held. Indeed, the sound elicited is as different in the hands of different persons as would be the sound elicited from the same thorax, with the same hammer and pleximeter, in the hands of a Piorry and of an untrained student.

The question of number may be approximately settled by the same instrument which establishes the question of size or density. If the instrument strike a calculus on one side, and can then dip down and move about in all directions without striking another, it is reasonable to conclude that the stone is single. If, however, the instrument can be made to strike in several directions, first on one side and then on another, and can then dip down, and, as it were, elicit a separate click, first on one side and then on another, it is reasonable to conclude that the stone is not single.

But this is not always reliable, and I am now in the habit of trusting to the lithotrite alone to elucidate the question of one or more. With a calculus firmly within the jaws of the instrument, the lithotrite is made to grope for other calculi, and to elicit sounds that could not be caused by the imprisoned stone. In this way the presence of at least a second calculus can be established; but more numerous ones are not so unmistakably made out. We may conjecture their presence, however, if the instrument seems to meet with numerous bodies in all directions, displace them easily, and dip down in all directions and still displace. But it is not safe to conjecture the number by using either the sound or the lithotrite. Twelve years ago I examined an old man with the sound and made out the existence of separate calculi, but how many I could not tell, though I suspected only three or four. I urged the use of the lithotrite, but he elected the knife. I did not regret his choice, as it enabled me to remove and save twenty-five stones of almost uniform size and shape, each about the size of a hazel-nut. The number of calculi in this instance could not be approximately conjectured before the operation.

But a circumstance of greater moment than the number of calculi, as it often decides the choice of operation, is their free or encysted position within the bladder. It would seem *a priori* easy to say when a calculus is free, and, when encysted, to determine the extent to which it is encircled. But in practice this is often found to be difficult. The sound may appear to move the calculus in all directions, but it may be the bladder which moves; or the calculus may appear immovable when it is entirely free, but within a contracted organ. The sound may be made to move around the calculus with great difficulty, yet the calculus may be free, for a large stone in a diseased and thickened bladder is not easily defined; and, on the other hand, the sound may be made to move around the calculus with much freedom though it be adherent. In 1872 I operated by lithotomy upon a boy from St. Ours. The stone was at once detected, and the sound moved around it freely, but more than half the calculus was deeply imbedded in the left ureter, from which, however, it was easily withdrawn. Sometimes the stone is more or less hidden in a pouch of the bladder from which it cannot be removed.

P. Derome, aged 72, had been for many years the subject of the usual symptoms of stone in the bladder. On examination, I found a calculus of about 1½ inches in diameter lying at the back part of the organ, behind the prostate. I used the lithotrite, and had no difficulty in reducing a considerable portion of the stone to powder. Short sittings, and not too frequent, were then in order. Ten days afterwards I again used the lithotrite, but was able to remove but a trifling quantity. I then suggested lithotomy, but to this the patient was reluctant to submit. He died, and a post-mortem examination, at which Mr. (now Dr.) Roddick assisted, showed a calculus, its free convexity broken away by the lithotrite, and reduced apparently to about two-thirds of its original volume, deeply imbedded in the posterior wall of the bladder.

It is not always easy, when sounding for stone, to distinguish between the surface of the mucous membrane of the bladder and the surface of the pouch in which the stone is imbedded, and especially when the stone is large, and the bladder rugous or diminished in capacity. But these sacs or pouches in the bladder, containing calculi, are fortunately of rare occurrence.

When the presence of a calculus is clearly made out, and its size, form, quality, and situation determined, means for its removal are to be considered, for the number of persons reported as cured without operation—either spontaneously, or by galvanism, electricity, or injections, even when conducted in that ingenious manner styled litholysis,[1] when the stone is large, or by the use of mineral waters by the mouth, bladder, rectum, or skin, in cases of smaller calculi[2]—is too small to justify the postponement of operative measures. Some persons, it is true, have been cured without operation. The calculi, when small, have passed by the urethra; but generally this spontaneous passage occurs soon after they have reached the bladder, and before they have attained the size of a grain of wheat or maize. Calculi have been known to find their exit by ulceration through the perineum and the rectum; but the faint hope of such a termination should induce no sane person to await patiently an event so unlikely to occur, and, if occurring, far more painful and hazardous than a well-conducted surgical operation.

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[1] Proposed, but, as far as I know, never practically adopted, by the late Dr. John Duncan, and published in the Edinburgh Medical Journal: the calculus was to be encased, while in the bladder, in a thin pouch of highly vulcanized India-rubber, introduced by a suitable contrivance; and with the interior of this pouch, containing the stone, free communication was to be had through the urethra by means of two small rubber-tubes, through one of which the operator could, at will, inject any stated quantity or kind of solvent which he might require for dealing with any particular formation, the remaining tube being for the exit of the disintegrated stone in solution.

[2] The curious in this matter are referred to the works of Ambroise Paré for a number of prescriptions in vogue at the time, and which received that writer's approbation, for the cure of stone without operation. They are, if nothing more, illustrations of the polypharmacy of the period, and comprise: "Syrop;" "Bouillon;" "Poudre singulière;" "Clystère;" "Autre clystère pour appaiser la douleur;" "Breuvage fort commendable;" "Apozème;" "Poudre fort propre à dissiper la matière du calcul;" "Clystère facile;" "Frictions;" "Vomissements;" "Bains;" "Décoctum pour faire un demybain;" "Décoction à faire clystère;" "Poudre propre à comminuer le sable," etc.

The methods of relief are practically but two: that by cutting and that by crushing. The first, notwithstanding the simplification of the operation, is still pregnant with danger, while advocates of the latter think it so little hazardous, and so well suited to calculi of every description, as to render the cutting operation under any circumstance uncalled for. But this is an error into which none but enthusiasts are likely to fall. To the first operation there must ever remain the dangers of shock, hemorrhage, inflammation, urinary infiltration, deep-seated abscess, gangrene, peritonitis, phlebitis, purulent infiltration, sympathetic affections of distant organs, as of the brain or pleuræ, or of the bladder, extending to the ureters, kidneys, or intestines, and the less grave risks of urinary fistula, incontinence of urine, injury to the rectum, etc. Each method of operating has its peculiar perils, though some perils are common to both.

Lithotrity has its own dangers; but whatever its dangers, whatever its disadvantages, the field for its employment is steadily widening, and lithotrity is, now-a-days, preferred to lithotomy in cases where, twenty years ago, the crushing operation would have been considered inapplicable. Even the conditions which were then considered essential to its successful performance—relating to the size and texture of the stone, the state of the viscus in which it is found, or of the channel along which the débris is to travel—are modified so as to admit a very much larger number of cases to this operation than was at one time thought to be possible. Lithotrity has its own dangers as well as its advantages, and to these and to those I shall now give attention.

Dangers and Advantages of Lithotrity.—The term *lithotrity*, in its most extended sense, may include the seizing of a small calculus in the bladder and its extraction by the urethra; it also includes the breaking up, compression in some way, crushing, squeezing, condensation, or perforation, of large calculi, and the removal of their débris, allowing this to pass by the urethra or to be washed out of the bladder. Manœuvres so various have received various names, and the lover of Greek may find terms to his fancy or his astonishment: lithocenosis, lithodialysis, litholaby, lithomyly, lithontripsy, lithotripsy, lithophagy, lithopriny, and lithotrity. The first eight have become almost obsolete; the last is now commonly used. In no department of surgery, perhaps, have advances been more steady and more signal than in this modern operation; modern as concerns most of its essential features. For nothing could be so unlike the present procedure as the use of the three-pronged forceps which seized and endeavored to penetrate or pierce the calculus, the maschabarabilia of the Arabs, or the four-pronged instrument of France. But there is no satisfactory evidence that before the beginning of the present century a calculus of any size had ever been removed from the bladder without cutting—the testimony of Colonel Martine to the contrary notwithstanding. The calculi said to have been removed were from the urethra, and not from the bladder.

There is nationality sometimes even in science, and, if we put aside the claims of Gruithuisen, who first taught that sounds of large calibre could be passed with ease through the urethra, the credit of having created lithotrity unquestionably belongs to France.

To Leroy d'Étiolles is probably due the invention of the greater number of instruments designed for crushing stone, and to Civiale their more extensive employment. It is a singular fact that the introduction of the lithotrite was coëval with, and in a measure resulted from, the use of the straight catheter. Until the beginning of this century, a curve to a catheter was considered a necessity. But the use of a straight instrument led to the invention of the lithotrite, which was again, in its turn, brought to a curve as the form of greatest adaptability.

The first lithotrites were curved; but they were soon afterwards made straight, to be again curved as they are now, and are ever likely to remain. It is useless to trace the gradations from the rough, complicated, and unsafe instruments of fifty years ago, to the elegant, light, yet strong lithotrites of to-day. The circumstance that a bloodless operation for the removal of stone was found to be possible, was sufficient to stimulate the ingenuity alike of surgeon and instrument-maker in many countries in Europe; and America, in the person of Ashmead, evinced a like interest. It stimulated, at the same time, an interest in the subject of lithotomy, and reopened a consideration of the various procedures for removing the stone whole.

But the two Frenchmen already named, to whom must now be joined Amussat, Charrière, Heurteloup, Mercier, Récamier, and Tonchu, of France, more recently Sir Henry Thompson, of England, and still more recently Prof. Bigelow, of Boston, have given in their beautiful closed and fenestrated instruments the best means of quickly reducing a stone to powder and of removing it from the bladder.

Various have been the methods advocated during these fifty years, but they may be all reduced to (1) perforation; (2) perforation and divulsion, or excentric rupture; (3) concentric or surface grinding; (4) crushing.

There is nothing brilliant in any of these methods, and no opportunity is afforded for dash or boldness, or even of *sang-froid;* near assistants may *hear* an occasional crushing sound; but neither they nor the operator can *see* anything. The latter could operate equally well were he blind, for, from the beginning to the end of the operation, it is carried on in the dark. And not alone in the dark, but the peccant body, lying hidden within the bladder, is not touched save by a metallic instrument, many inches in advance of the operator's fingers. From the first discovery of the stone till its final removal from the body, there is, there can be, no contact except mediately through a metallic instrument. Of no operation in surgery can this more truly be said: "We see not what we attack, and touch not what we remove."

On several occasions I have published in the medical press some practical observations on lithotomy and lithotrity, and on the selection of the cases suitable to each operation. But every succeeding year has taken from the former and added to the latter.

Age, at one time considered an essential element in the choice, is so no longer. Even children in whom the shallowness of the perineum and the unirritating nature of the urine seemed fairly to indicate lithotomy, are now subjected to the lithotrite. Nor does old age, with its accompanying enlarged prostate, any longer forbid or render less satisfactory the operation of crushing, and since Mr. Henry Smith, of King's College Hospital, London, lithotritized with success, more than twenty years ago, a man of more than eighty-one years, persons of the most advanced age have been similarly treated.

The *state of the urethra* has much to do with the choice and also with the success of the operation; that tolerance or intolerance of the urethra—"the temper of the urethra," as Sir Benjamin Brodie styled it—which "varies as much as the temper of the mind." This tolerance or intolerance of the urethra for instruments may be easily understood by those who have noticed the great tolerance of some urethræ, and the equally great intolerance of others, for injections. There are some urethræ so tolerant of strong caustic and astringent solutions as to appear unaffected by them; while there are others so sensitive that even the most trifling addition to tepid water causes urethritis or cystitis of alarming severity. Injections of tepid water alone often arouse inflammatory action. Before the practice of rapid lithotrity became general, when several sittings were necessary for even moderate-sized and friable calculi, this was a question of moment. But it is so no longer, and the urethra that can tolerate the grooved staff for cutting purposes, can alike bear the use of the lithotrite. The irritation sometimes set up in the urinary apparatus by the too-prolonged and too-frequent introduction of the lithotrite, is not usually irritation of the bladder, as is commonly supposed, but of the urethra; and the severe constitutional disturbance which often follows, results from the passage to and from the bladder, and not from any trouble lit up within that viscus. The bladder is not easily irritated; but the urethra is relatively sensitive and prone to disturbance. A large calculus, when broken up, as long as it remains within the bladder gives but little discomfort; but the passage of the smallest fragment causes both pain and disturbance of the circulation. It was the recognition of this greater sensibility of the urethra, probably, which led to the use of the external canula, or "chemise," as it was termed, which was placed within the urethra to protect its walls, but which is now no longer to be met with save as a curiosity in the surgical cabinet, though the sensibility of the organ which it was intended to protect has continued the same.

Nor is *stricture*,[1] whatever may be its character or situation, even if it have become cicatricial, to be regarded as an obstacle to the performance of lithotrity. If the crushing operation would be selected without stricture, it should be the more readily selected where stricture exists. Some of the most successful operations of which I have knowledge have been performed after the patients had undergone treatment for stricture. Nor are those heteroplastic growths which grow in and around, and press upon, the urinary canal, to offer insuperable obstacles to lithotrity, unless they are themselves not amenable to treatment.

The treatment necessary for the cure of stricture, whether single or multiple, and whether situated in the membranous, bulbous, or penile portion of the urethra, as a preliminary to lithotrity, familiarizes the ofttimes capricious, coy, and uncertain canal to the presence of instruments, and renders the subsequent use of the lithotrite comparatively free from irritation. When dilatation alone is practised, the bougie brings the calibre of the urethra up to and beyond that required for the lithotrite, and when incision with dilatation, or internal or external urethotomy, is practised, the same result is obtained.

But other circumstances have a controlling influence on the selection or rejection of lithotrity: to wit, the size and hardness of the stone. The *size* of the calculus is less regarded than formerly, and, provided that the stone is not too hard, size alone should not prevent the performance of lithotrity. The comparatively early detection of stone, while it is yet small, has rendered the operation of lithotomy less needful. Large stones are met with less frequently than formerly. Now and then our hospitals furnish cases of stone of large size in individuals who have lived far from the aid of surgery, till forced by long suffering to find their way to the larger cities; but since the practice of lithotrity has become more general, and the detection of stone more early, calculi have been steadily decreasing in size, and promise to do so still more in the future.

The *hardness* of a stone may generally be recognized by the resistance it offers to the lithotrite, and by the manner in which the jaws of the latter grasp it. But the seemingly unmistakable evidence of hardness or of softness thus elicited, is liable to error: the stone may not be the same throughout:—

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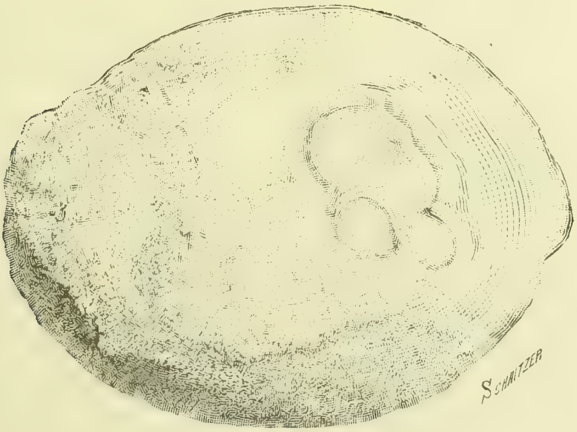
[1] By the term stricture I mean that organic stricture, that change in the wall of the urethra, either in the mucous or submucous tissue, by which is offered a greater or less impediment to the easy flow of urine. "Spasm" and "inflammation," as Mr. Reginald Harrison well observes, "may be superadded, but they do not constitute stricture in the acceptation of the term which is now generally adopted."

D——, aged 21, on the 17th of July, 1873, came to me from Syracuse, in the State of New York. He had been a sufferer from infancy. On his admission to the hospital I at once struck an enormous stone. It seemed to be soft however, and I decided to employ the lithotrite. At the first sitting a large quantity of very soft phosphatic matter was broken off and reduced to fragments, which came away during the following week, when the second sitting was begun; but the jaws of Civiale's strong-toothed instrument closed upon a calculus seemingly unlike that previously felt. The screw was applied, and as much force used as was consistent with the integrity of the lithotrite, but no impression whatever was made upon the calculus. I at once resorted to the knife, and by the lateral method safely removed a stone measuring nine and a half inches in its greatest circumference, and weighing five ounces and five drachms—the largest stone I have ever seen removed from a living body. An inspection of the specimen showed that no instrument hitherto devised could have crushed it, and that no operation, however prolonged—not even the two thousand strokes which Leroy is said to have given a calculus ineffectually—could have caused its disintegration. Its shape was a somewhat flattened ovoid. One end was partially covered with nearly a half-inch coating of soft phosphatic deposit; the other end, which rested upon and was partially encysted in the bladder, was a rough uric-acid stone; but the greater bulk of the calculus, and the part upon which the lithotrite could make no impression whatever, was of oxalate of lime. The varied structure—so adapted to mislead—and the enormous size of this stone, led me to present it the same year at a meeting of the Canada Medical Association, in St. John, New Brunswick, and I introduce here an engraving from a full-sized photograph. The patient, I may add, made a rapid recovery. In this case an examination of the urine, and even of the débris of the stone itself, would have been misleading, as the outer coating alone was soft, while the interior was of the hardest character.

Fig 1275.



Large oxalate-of-lime calculus, with external phosphatic layer.

State of Bladder and Kidneys.—What condition of the *bladder* contra-indicates the operation of lithotrity? I know of no condition of the bladder which *alone* should influence a decision in favor of lithotomy, which could not with equal reason be deemed favorable to lithotrity. Nor yet the state of the *kidneys:* although, as in other operations, it is desirable to have these organs in a healthy condition for removal of stone from the bladder, I know of no condition which forbids the operation, though it may have much to do with the choice of the method to be adopted.

PRELIMINARIES TO LITHOTRITY.—Surgical writers, generally, have recommended (1) that the irritable bladder should be deprived of its irritability by emollient injections before the operation; (2) that the urethra should be habituated to the passage and presence of metallic instruments before using the lithotrite; (3) that the bladder should be partially filled with tepid water or other fluid; and (4) that, when the bladder cannot retain urine for two or more hours, recourse should not be had to this procedure.

(1) In the first place, the readiest way to diminish the irritability of the bladder is to remove therefrom the calculus which has given rise to it. Emollient injections are useless, and are sometimes a source of mischief.

(2) If the urethra can be accustomed to, and become tolerant of, the sound or metallic bougie, it can as readily become accustomed to and tolerant of the lithotrite at the time of the operation. But it must be borne in mind that there are, on the part of the urethra, periods of tolerance and times of intolerance of the presence of instruments, independent altogether of the duration of their employment. At one time the urethra will bear the presence of an instrument, and at another it will not, and this without regard to the size of the instrument. It is difficult to account for this varying tolerance of instruments. It is a fact, however, known to all surgeons, and alluded to by many. Gouley says: "The instrument may have been passed at regular intervals for weeks or months without any very great amount of pain, and without giving rise to any discomfort; or it may have been followed on one or two occasions by a mild attack of fever; but finally the same careful catheterization is practised—but *on the wrong day* perhaps, when the patient's functions are temporarily disordered—and in a few hours he is suddenly and unexpectedly seized with a severe rigor from the effects of which he may never rally."

A surgeon of distinction in this city had completed very successfully the operation of lithotrity, and the patient, relieved of his sufferings, had left the hospital and had returned to his home in the country. Some months afterwards the surgeon, being near the residence of his patient, called to see him and suggested an exploration of the bladder. A metallic sound was carefully introduced, but ere it had reached the bladder the patient was dead.

On August 20, 1881, A. B., aged 13 years, was admitted to the Hôtel-Dieu suffering from symptoms of calculus. Chloroform was used, and a metallic No. 6 sound was introduced; the bladder was explored, but no stone could be detected. No inconvenience whatever resulted from the examination, and the little fellow continued to run about the ward as if nothing unusual had occurred. Three days afterwards he was subjected to an examination of about the same duration. No difficulty was experienced in entering the bladder, no difficulty was experienced in the easy movement of the sound when within it, and no hemorrhage followed. Later in the day I was summoned to the patient's bedside, and found his condition to be alarming. He had had a rigor which had lasted a couple of hours; he had now a pale and anxious countenance, and a weak, thread-like pulse (140), and cold extremities. From this condition he did not rally, and he died in the afternoon of the following day, twenty-eight hours after the second exploration. The anæsthetic (chloroform) and instruments (No. 6 long, curved, silver sound, and Sir H. Thompson's explorer) were the same in both instances, and employed by the same persons; and the duration of the examination on both occasions (about six minutes) was about the same, and on both occasions in presence of the same class, in the same surgical theatre. The body was so quickly claimed by the relatives that no post-mortem examination was obtainable.

(3) The suggestion to fill the bladder with tepid water, or at least to introduce eight or ten ounces, is made under the impression that the movements of the instrument will thus be freer, and that the detection and seizure of the stone will be easier. But this impression arises from a misconception of the true state of the bladder. That viscus is but sparingly supplied with mus-

cular tissue, and it is not contracted upon its contents, as is the uterus. The walls of the bladder lie in easy apposition, and the lithotrite can move about as readily in an empty bladder as in a full one. This experiment may be easily performed on the dead subject. Indeed, of the two, I prefer the empty or nearly empty bladder to a full one. I do not request the patient to void his urine, but I do not ask him to retain it too long. It is a matter of indifference.

(4) It follows as a corollary, from what has been said, that the circumstance that the bladder cannot retain urine for some hours is not a reason for rejecting lithotrity for lithotomy. It often happens that the subjects of stone cannot retain their urine for more than a few minutes, and some, not for a moment:—

In 1872, Mr. W. S. came to me from Quebec, for the removal of stone. For several years he had been unable to retain his urine. Incontinence was complete. A caoutchouc bag was attached to the penis, and a tube led from it to a larger one which he carried in the leg of his boot. The parts were so excoriated and his sufferings so great that I advised him to submit to the knife. To this he would not consent, and, contrary to my judgment, I was constrained to use the lithotrite. At the first sitting I crushed two large-sized uric-acid calculi, and repeated the operation three days afterwards. After the first operation, and before any of the débris had passed away, the patient could retain his urine two hours; after the second sitting he retained his urine a much longer period; and after the third and last sitting, he was able to retain his urine as long as ever in his life, and, as far as I know, his condition has continued comfortable ever since.

Injections.—There was, in the early years of lithotrity, remarkable unanimity of opinion in favor of drawing off the urine and injecting into the bladder a certain quantity of warm water, as a preliminary to the use of the lithotrite. There was also remarkable unanimity of opinion as to the quantity—and not less than four ounces, and usually not more than six ounces, was regarded as the cycloid within which it was deemed safe and wise to oscillate. It was also considered necessary to know what quantity of water the bladder would tolerate within it, and, this quantity being a known quantity, the bladder's capacity, ascertained in this way, became its known capacity. It was also imagined and taught that, tepid water being less irritating than urine, the bladder would be tolerant of the presence of a greater amount of the former than of the latter fluid. But urine is proper to the viscus which contains it, and is less irritating to its coats than any foreign fluid, however bland, just as the secretion of the lachrymal gland, more irritating than water, is more grateful to the eye which it bathes; moreover, as Pollock says, "other things being equal, there is no benefit in tepid water over urine as a medium in which to crush a calculus." In later years the orthodox four or six ounces was reduced to two ounces, and still more recently some distinguished operators have discontinued the use of injections altogether. I have never practised filling the bladder with warm water: it seems to me but a mischievous and unnecessary meddling, and the reasons for the use of injections have never appeared to me cogent. On the contrary, I have always observed that when practised by others the procedure is a painful and distressing one, not free from danger, and of a nature to arouse patients from apparently deep sleep. Indeed, I have generally noticed that the injection causes more pain than the sound or lithotrite, and that even when chloroform is used, there is rarely an occasion on which the sleep is so sound as not to be easily disturbed by the injection. Some surgeons, however, run into the extreme of operating only when the bladder is full, and when the patient is experiencing a strong desire to micturate. It is preferable to operate when the bladder contains some fluid, and a practical method is to suggest to the patient not to make water immediately before submitting to the employment of the lithotrite. Sir Henry Thompson's plan is a good one—to ask the patient "to retain his urine for a little less than his accustomed period before the sitting; that is, if naturally he is able to retain his urine for about an hour, he is requested to pass it forty minutes before the time of the visit." In this way the inconvenience of an empty bladder, and the still greater inconvenience of a too full bladder, are both avoided.

But even this moderate desire for a small quantity of urine in the bladder cannot always be gratified, as in the case of the gentleman from Quebec to which I have already referred. I reluctantly employed the lithotrite in this case, yet I never had a more favorable recovery. Since then I have never regarded with any apprehension the opening and closing of a lithotrite in a bladder which was intolerant of the presence of even the smallest quantity of urine, nor has it occurred to me to supplement the vesical contents with warm water. Injections have been recommended in the erroneous belief that without them the play of the instrument would be restricted, or that the walls of the bladder would be caught between the blades of the lithotrite and injured. But it should be borne in mind that, as already pointed out, the walls of a healthy bladder are not closed and contracted upon its contents, but that they lie loosely and lightly in contact, receiving within them the water which trickles along the ureters without any *vis a tergo* or pumping power in kidney or ureter. The degree of fulness of the bladder admittedly influences the search for stone. Acting on this assumption, Civiale had constructed a lithoclast—a small, short instrument with a groove along the centre of the male blade—which permitted the urine or the injected fluid to escape slowly; and, while it was escaping, the instrument was turned in every direction to search for the stone.

Size of Lithotrite.—It was formerly the custom, sustained by the approval of the late Sir W. Fergusson, to commence the operation with a large-sized lithotrite; to break the stone into pieces, and then to take a smaller instrument to reduce the fragments to less proportions, so that they might more readily pass through the urethra. But if the lithotrite used in the first instance be not too large, not more than 11 or 12 of the English scale—one not too large to be easily manipulated, yet not so small as to be in danger of being bent or broken—it is better to keep to the same instrument throughout. The length of the instrument must be proportionate to the length of the canal. In children the canal is short, and a short, small-sized instrument suffices; but in cases of enlarged prostate in elderly persons, where the canal, especially at its prostatic end, may be elongated several inches, the necessity for a long lithotrite is obvious. A lithotrite of about twelve inches is sufficient for ordinary purposes; but, in some cases, anything under fourteen and a half inches would be inadequate.

Method of Operating.—The patient's body should be so elevated that the surgeon's right arm, while operating, may be nearly horizontal. If the patient is in bed, the surgeon should be seated at his side; if the patient is on the operating table, the surgeon should stand.

The operator being upon the right side of the patient, who lies upon his back, with his head and shoulders elevated and his thighs flexed, the closed lithotrite, well oiled and in the right hand, is slowly introduced within the meatus in the same manner as an ordinary catheter, the penis being supported merely—not seized—by the index and middle fingers of the left hand. It is of small moment on which side the operator chooses to place himself; but it is of importance that, having elected one side, he should keep to it.

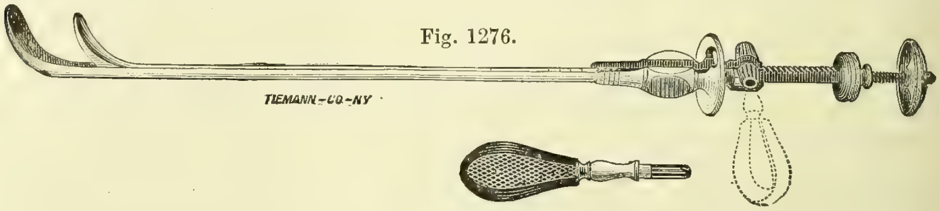
At the beginning of my hospital career the right side of the patient seemed to me preferable, and I adopted it, and now, from habit perhaps, consider it the easier and more natural one. I therefore recommend it. It was the position which I generally saw selected by Civiale and by Sir Philip Crampton. The introduction of the lithotrite is practised by some indifferently, either sitting or standing, and on the right or left side of the patient.

If, with an instrument of such inconsiderable weight as a catheter, it is not allowable to add much additional weight, still less is it allowable with an instrument already many times heavier. The increased weight of the lithotrite is alone more than sufficient, when once it has passed the meatus, to insure its passage along the urethra and into the bladder. The calibre of the canal is nowhere less than at the meatus, and here alone a slight amount of pressure, with a somewhat rotatory movement, may be allowable. The meatus is rarely as wide as the rest of the urethra, even in the healthiest persons and in those who have never had balanitis. My experience in this respect corresponds with that of Mr. Berkeley Hill, who thinks that the meatus is "normally narrower than the rest of the canal, or that its morbid contraction is exceedingly common." The meatus once passed, no difficulty is generally experienced till the instrument is beneath the pubic symphysis, when its handle must be depressed. This carries it beyond the membranous portion, where delay sometimes occurs, and to the prostatic, where difficulty is sometimes experienced, especially in old men, in whom prostatic enlargement is usually accompanied by elongation of the corresponding portion of the urethra, to such a degree as sometimes to lead the inexperienced surgeon to believe that his lithotrite is already in the bladder, when its point may be impinging against the superior wall of the urethral canal. When within the bladder, it is advisable to advance the instrument well along the floor of the organ, to make sure of its being completely within the cavity, before commencing the search for the calculus. Not infrequently the instrument as it advances strikes against the stone. If not, it is to be again slowly withdrawn to just within the neck, when the instrument is made to dip gently from right to left and from left to right of the median line, then from front to back and from back to front. Sometimes the point of the instrument requires to be elevated, sometimes to be dipped backwards, but always with the greatest gentleness; and sometimes, also, the difficulties experienced when searching with the sound are again renewed with the lithotrite, difficulties arising in great measure from concealment of the stone in a saccular depression behind an enlarged prostate, from the floating about of a small calculus in a capacious bladder, or from the diminished space in an irritable one. Sometimes it is considered necessary to turn the patient on either side, and various contrivances have been suggested and used for the purpose, the most complete perhaps being that of Reliquet, which elevates the pelvis at will or turns it in either direction. But without any special apparatus an air pillow will be found convenient. I have never had occasion to turn patients upon the side, and prefer having them always upon the back. One is less apt to forget the relations of the lithotrite to the body when the patient is in that position.

When the calculus is touched with the still closed lithotrite, it is well to determine on which side it lies, so that the instrument, when opened, may the more readily grasp it. But though desirable this is not essential, and the investigation should not be pursued at the expense of any suffering from manipulation that can be avoided. When the stone is again felt, the male blade is gradually withdrawn and again pressed home, while the female blade rests against the back of the bladder, the penis in the mean time being gently held in position. In this way the stone will generally be at once seized within the blades. If not, the instrument is again and again opened and closed, while gently turning it to the right and left, and backwards and forwards.

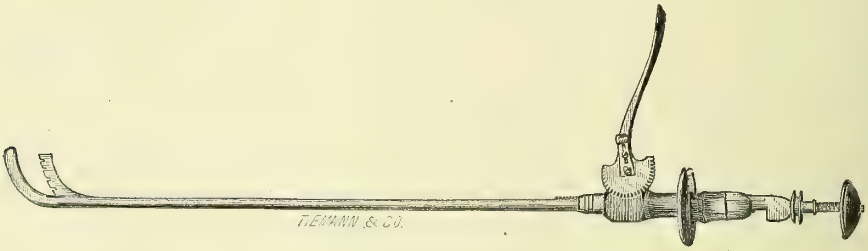
When seized, the stone is to be dealt with according to the particular method which has been decided upon. If it is contained within a litholabe, the stone is broken with blows from a hammer, of sufficient force and quickness to crush it without injuring the instrument.[1] If with the rack and pinion lithotrite, the penis is held in the same manner, and the handle, which is sometimes on the right side, sometimes on the left, is worked by the right or left hand, the penis and contained instrument being held by the other. As the rack-and-pinion instrument cannot be worked without more or less movement of its point within the bladder, it is objectionable. The same objection applies with equal force to the lever instrument (Fig. 1277), which requires too much movement of the right hand. I have discarded both for the, to my mind, more satisfactory lithotrite of Civiale, which may be easily worked, with or without the screw, this being released or attached by turning what instrument-makers call the revolving cap. Weiss's lithotrite has all the advantages of Civiale's, and also an additional merit. The screw power is in connection with the male blade, and is more readily released, this being accomplished by placing the thumb of either hand upon a button on the handle, the movement being effected in a line with the shaft of the instrument. But the cylindrical form of the handle, added by Thompson, though admitting of greater force in the hands of the operator, does not permit the same delicacy in manipulation as does Civiale's round-headed instru-

Fig. 1276.



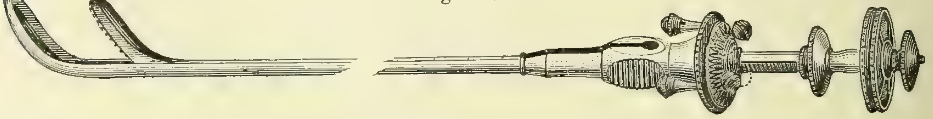
Rack-and-pinion lithotrite.

Fig. 1277.



Lever-lithotrite.

Fig. 1278.



Civiale's lithotrite.

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[1] I mention this method, though now obsolete.

ment. That instrument is, however, the better to which the operator is the more accustomed.

Sir Henry Thompson's lithotrite[1] has considerable advantages for stones that are neither too large nor too hard. The instruments hitherto described are fenestrated. Thompson's has a small opening, yet for all practical purposes is closed, and the depression in the female blade permits it to receive and retain a considerable quantity of the fragments, which may generally be removed without injury to the canal. The means of releasing and of attaching the screw are placed on the handle of the female portion of the instrument. But to Thompson's, as to all flat lithotrites insufficiently fenestrated, there are these objections: they become quickly filled with fragments, large and small, and the female blade, no matter how full, still permits additional matter to be pressed into it by the male blade, when perhaps the blades, separated by calculous matter, cannot be accurately closed, and have to be withdrawn in this way through the urethra. I have more than once seen difficulty in removing this instrument, and especially through the narrower portions of the urethra, where lacerations have apparently taken place. It is not always easy to prevent the overloading of the female blade, for the first turn of the screw or the first pressure of the unaided wrist may impact it with more than it can contain. The most dexterous must be prepared for this occurrence. Before the time of rapid lithotrity, before the time of washing out the bladder after the operation for crushing, Sir Henry Thompson's instrument was deservedly a favorite one. It enabled the operator, with a fair-sized urethra, and one tolerant of manipulation and of the presence of instruments, to introduce any number of times an empty lithotrite, and remove a full one. And many times have I completed the operation of lithotrity in this way in two or three sittings. But, as already stated, repeated introductions and withdrawals are not advisable, however carefully performed, and a prolonged sitting means correspondingly numerous passages of the instrument through a sensitive canal. There are many cases, however, in which Thompson's lithotrite is still the best—cases in which friable and moderate-sized calculi are met with, and in which the urethra is capacious and possessed of a minimum degree of sensibility.

Bigelow's lithotrite[2] has few advantages over Sir H. Thompson's and Civiale's flat instruments, save that it has a longer and larger female blade, turned down at the end to facilitate its introduction, and fenestrated at the heel for the reception of a projecting shoulder on the male blade. It is a flat instrument, and may be choked in the same way as Thompson's or Civiale's. When closed, the male is completely hidden within the female blade. The instrument breaks the stone effectually, but does not reduce it to fragments. To do this the broken pieces must be seized again and again. Its crushing power is not by any means equal to that of the open, fenestrated instrument; and it works by continuous pressure rather than by sharp, distinct, and interrupted crushings. The absence of lateral guides on the handle, to tell when the screw is on or off, is confusing; but the instrument-maker can easily remedy this defect.

Dr. Gouley's lithotrite (Fig. 1279) has some advantages not possessed by other instruments, but has disadvantages also. The edges are sharply cutting, but the bulk of the stone must be reduced by pressure, and pressure of a continuous kind. The dread of cutting the walls of the bladder by an instrument apparently equal to that work, is ill-founded. In this respect its construction offers nothing more hazardous than that of the instruments longer in use.

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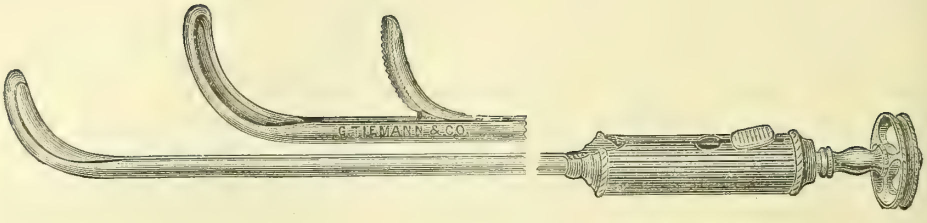
[1] See Figs. 1204–1210, pages 221, 222, *supra.*

[2] See Figs. 1211–1213, page 223, *supra.*

Fig. 1279.



Gouley's lithotrite.

France, unwilling that other countries should outstrip her in the perfection of instruments for crushing stone, in which, for so many years she excelled, has not been idle. Civiale's, Heurteloup's, and Leroy d'Étiolles's instruments have been variously modified in handle, shaft, and blade. But more recently Reliquet has furnished a lithotrite which has certain advantages over other instruments, especially in reducing calculi to fragments sufficiently small to enable them to pass through the evacuating canula.

The advantages of Reliquet's instrument are chiefly these: (1) the oblique disposition of the teeth on the margin of the female blade prevents the calculus from slipping towards the point when the teeth of the male blade cut and crush it. (2) The teeth of the male blade act singly upon the imprisoned calculus, and drive it against the transverse teeth in the female blade, between which it is reduced to the desired size, the fragments falling behind and out of the way of the male blade. Hence (3) the disadvantages of over-filling the female blade, and of necessitating the frequent withdrawal of the lithotrite to clean it, as in flat instruments, are avoided. But there is also a drawback to the general use of the instrument. When it is closed, the teeth of the male blade project beyond the female, below, and the serrated margins of the female blade, above, are free. In its closed condition the instrument can neither be introduced nor withdrawn; the blades must be partially open, and by a piece of mechanism this action is limited. Operators familiar with other lithotrites, which are always firmly closed prior to introduction or withdrawal, are apt to be unprepared for this novelty. A small blade, less deep, and one which would occupy less space when closed, would answer every purpose. In spite of this defect, however, much of what its enthusiastic inventor claims for it must be admitted, and especially the advantages of a flat instrument without the inconveniences of clogging, enabling the lithotrite to be manipulated for any length of time within the bladder without the risk of difficulty in its removal. It can be used with the pressure of the palm of the hand, or with the screw as in ordinary instruments, or, in cases of hard stones, with percussion by a hammer.

Duration of Operation.—This also has been greatly modified. French surgeons place the utmost limit of duration, beyond which it is imprudent to go, at twelve minutes. "Après cinq, huit, dix, ou tout au plus douze minutes, il convient de terminer la séance," says Velpeau. Other operators since then have greatly increased the duration of the operation. I have many times manipulated the lithotrite for an hour, and Bigelow in this country, and many operators in Europe, have advocated much more prolonged sittings, but, as I shall have occasion to point out, the risk to the patient is not diminished thereby.

RAPID LITHOTRITY.—It was, as it were, but a swing of the pendulum between permitting, in all cases, the fragments of a calculus to find their way out of the bladder, without injection and without aspiration, and allowing no portion of a calculus to remain after fragmentation without being washed out through the urethra, or drawn out through a canula.

If error there were in the former practice, the error was in its universal adoption. And the error into which many have recently fallen, of washing away the fragments in every instance, is an error fraught with no less mischief. It is but a few years since the greatest surgeons were content with "crushing the stone, and waiting for the gradual and spontaneous egress of the fragments." Some, like Fergusson, had tried single and double injections and currents of water, but with so little satisfaction that "forcible disintegration and chance were finally trusted to," chance generally bringing away in due season the fragments which had been broken off, after they had lodged perhaps for a time in the prostatic or membranous portion of the urethra, or at the meatus. It is less than twenty-five years since it was generally considered unwise to touch fragments of stone in the bladder, or to attempt to bring them away.

In speaking of injection as a preliminary to crushing, I gave among the reasons for its non-employment, the irritation set up in the bladder which it was not in the power of an anæsthetic completely to mask; the same objection would obtain, in a considerable proportion of cases, to the use of injection as a sequel to crushing. Professor Andrews uses "warm carbolized water during the whole operation of litholapaxy, both to distend the bladder during the crushing, and to wash out the fragments afterwards;" but, granting that "carbolized water acts as a decided local anæsthetic, benumbing the nervous activity of the bladder and lessening the shock of prolonged operations;" granting that "it checks bleeding, and leaves the viscus in a thoroughly antiseptic condition, preventing the formation and putrefaction of pus, and acting as a very powerful local antiphlogistic"—granting all this, and it is granting much—the wisdom of its use in mechanically distending the bladder as a preliminary to, or during the operation of, crushing, may fairly be doubted. The addition of carbolic acid to water cannot diminish—and it is not pretended that it increases—the undesirable *mechanical* action of warm water forced into the bladder through the urethra, though in the cystitis which accompanies the presence of stone, and which may continue after its withdrawal, the injection of a warm one-per-cent. solution of carbolic acid may be, as Mr. Batterham says, "most efficacious in allaying pain."

The aim of every operator, from the time of Civiale to the present has been, however, to diminish the inconveniences arising from the passage of these fragments. The fragments produced by the earlier instruments were not as large, indeed, nor as angular, as those produced by later instruments. The earlier lithotrites did not break the stone into pieces, but scraped its surfaces and gradually reduced it to powder or to small gravel, and the quantity broken down at each sitting was not as large as that obtained now. Yet fragments of considerable size could sometimes be detached. Accidents which occurred from time to time from their being lodged in some part of the urethral canal, led Leroy d'Étiolles to recommend an evacuating canula, and Heurteloup to introduce an instrument which has since, in the modification of Sir Henry Thompson, nearly reached perfection as a means of retaining the fragments within the female blade and permitting their extraction in this way. But this latter instrument is used on the assumption that the urethra is less susceptible of mischief from the introduction and withdrawal of a metallic instrument, than is the bladder from the presence of fragments. Civiale desired the detention of the latter within the bladder till their angles were rounded off, and Heurteloup advised the maintenance of the recumbent posture to retard their departure. This practice has since, till comparatively recently, been very generally observed.

For washing out the bladder, it is necessary that tepid water should reach the organ in sufficient volume to bring back with it in its refluence the débris of the calculus. It is necessary, therefore, that it should reach the bladder with a certain degree of rapidity, and with a certain amount of force. And here precisely is where the difficulty appears to occur: an elastic bag in the grasp of an assistant's hand at one end of an unyielding tube; and a bladder more or less diseased—with ureters perhaps unhealthy, and kidneys more or less changed in structure—at the other. Every pressure of the hand on the rubber bag is felt at every portion of the bladder, and through the constricted orifices of the ureter, the pelvis of the kidney, and even through its tubuli uriniferi at the cortical walls. I confess that in the performance of rapid lithotrity, my chief anxiety formerly began with the injections; not that the integrity of the passive, good-natured bladder was to be feared, but rather that of the delicate structures beyond, whose office it was to separate from the circulating fluid the peccant urea which it contained. For, however correctly we may estimate the propelling force at one end, we cannot so easily estimate the resisting power at the other. Sometimes the bladder commences its expulsive efforts at the first entrance of the fluid, and it is not easy to distinguish between the normal resistance offered by a healthy bladder when full, and the spasmodic efforts of an irritable one to prevent its becoming full.

The bladder may, without much disturbance of its functions, suffer a certain degree of gradual distention from within; but distention from without by a fluid which, however bland, is foreign to it, is not equally free from mischief. I have always observed, when patients have been under the influence of chloroform, and have generally been assured by those who were not under the influence of an anæsthetic, that their sufferings began with the injection of water, and not when the lithotrite was doing its work of disintegration and before any effort was made to urinate. Still, as the advantages of getting rid of a calculus are so great, and as there are but two methods of effecting this rapid delivery, that by washing out the bladder will continue to be the favorite in the greater number of cases. But great gentleness in manipulation and lightness in pressure, with due recognition of the resistance which the bladder offers to the distending liquid, must be cultivated. As the accoucheur can perceive uterine contractions before the patient herself, so likewise can the surgeon recognize the efforts of the bladder to expel its contents before the patient is aware of them.

But rapid lithotrity, in the days when it was first recommended, was not what is meant by that term to-day. Rapid lithotrity meant operating as long and as often as it was believed that the bladder would tolerate the presence of a solid instrument within it, without in any manner jeopardizing its integrity. Rapid lithotrity meant crushing a stone, waiting for the bladder to recover itself (a period usually thought to be not less than three or four days), and then searching for the fragments and dealing with them as in the first instance; and that lithotrity was most rapid in which the shortest interval existed between the sittings. Cautious men allowed intervals of ten or fifteen days, and limited each sitting to four or five minutes. Rapid lithotrity to-day, however, means something far more rapid and far-reaching in its operation, and far more satisfactory in its results. Rapid lithotrity often means the removal of a calculus at a single sitting; a most desirable result, certainly, but one which must sometimes be purchased at the expense of much unnecessary inconvenience and suffering. Rapid lithotrity, conducted with care and prudence, and with due regard to the patient's general and local condition, is a most satisfactory procedure; but rapid lithotrity, when it means the invariable completion of the operation at a single sitting, may mean suffering, disaster, and death. Long sittings are not invariably well borne, and are, therefore, not invariably wise. It must not be imagined that, because the patient is anæsthetized, no inconvenience will result from prolonged manipulation. The same intolerance of instruments may exist when the patient is asleep as when he is awake, though he may be unable to give any outward manifestation of that intolerance. To generalize the application of long sittings, therefore, is a grave error, and success is more likely to attend the practice of those who correctly appreciate the degree of irritability proper to the individual bladder, and proportion the length and duration, and the force, of their manipulations, with due regard to the balance of all the parts entering into the formation of the urinary apparatus, than of those who regard only the size and hardness of a calculus, and the cubic capacity of the viscus which contains it. Not alone has the bladder to be considered: to my mind the condition of the urethra is of still greater moment; not alone its calibre, but its individuality, so to speak; and more than these, the kidneys—those organs which are so often at fault in calculous subjects, and which, unluckily for the operator and for the patient also, may be diseased without giving rise to any appreciable abnormal condition of the urine. The first break in my last series of thirty-five successful cases of lithotrity occurred in this way.

One of the most marked modifications of this operation, which more than any other, perhaps, has undergone important changes since the days of Civiale, who, less than sixty years ago, first introduced it to notice, is the getting rid, without cutting, of a stone even of considerable size at a single sitting. This important modification is due in principal measure to Dr. Bigelow, of Boston, who advocates crushing the stone, and washing out all the débris, at a single sitting. It will not take from the great credit due to Professor Bigelow, for it to be said that the recommendation to wash out the bladder did not originate with him. More than twelve years ago, Dr. L. Aug. Mercier, in a little book entitled "Traitement préservatif et curatif des sédiments, de la gravelle, de la pierre urinaire, et de diverses maladies dependant de la diathèse urique," recommended washing out the bladder, and gave a cut of an instrument made for him for the purpose some years before by Charrière, of Paris, and which was not unlike the first India-rubber bag employed in this country. Mercier's method was not generally adopted, however, and it was usual till quite recently to trust to chance for the passage of the fragments. It was only when chance did not suffice that return was again had to the lithotrite, and to large-sized, large-eyed catheters, or to the use of a small scoop.

But the instrument now used by Bigelow so far surpasses Mercier's, that it may be said to be a new one; and the knowledge acquired, chiefly through the observations of American surgeons, of the greater calibre of the male urethra and of its greater tolerance of large-sized metallic instruments than was formally believed, has changed the views of lithotritists as to the best means of dealing with the fragments of a calculus. Judging from the improvements which are constantly being made in it, Bigelow's instrument may not yet have reached its highest point of perfection; but in its latest form[1] it closely approaches it.

There remain to be said a few words on the method of using it; the work of crushing being ended, a canula of the full size of the urethra is introduced, when, warm water being in readiness and the canula being attached to the pumping apparatus, the slightest pressure of the fingers and thumb on the rubber ball—a force not more than sufficient to dimple its walls—suffices to agitate the fragments of the calculus and bring them within the large eye of the tube. The appreciation by Dr. Bigelow of the very gentle pressure which suffices to put in motion fragments differing but little in specific gravity from the fluid in which they were originally formed, entitles him to the gratitude of every sufferer from vesical calculus who desires to be rid of it with the least possible delay, and with the least possible pain.

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[1] See Fig. 1232, page 238, *supra*.

LITHOTRITY IN THE FEMALE.—We are not often called upon to operate for stone in the bladder in the female. The anatomy of the female urinary apparatus favors the early escape of calculi through the urethra, and before they have attained a size to require the surgeon's assistance. But in those exceptional cases in which the calculus remains within the bladder, it must be extremely rare for any other operation than crushing to be called for. If neither stricture nor enlarged prostate is an insuperable obstacle to crushing in the male, how much more favorable is the female urethra for the manipulation of crushing instruments? Its shortness and its large normal calibre, susceptible of considerable increase by the use of the lithotrite, render extraction of stone by incision into the bladder, either through its neck or through the vesico-vaginal septum, rarely necessary; and still more rarely is the more formidable supra-pubic operation called for, except in cases of immensely large and hard calculi.

LITHOTRITY IN CHILDREN.—For a long time it was felt that in children, at least, lithotomy would continue to hold its place, the operation on them being usually considered an easy and a safe one. But, however safe the operation may usually be considered, and however easy of performance, we sometimes meet with unexpected difficulty and delay in its performance, and with disappointment in its results. The most accomplished surgeons have failed to reach the bladder, the left index finger going deeply into the perineum and pushing the prostate and neck of the bladder before it, and have well nigh abandoned the operation under the impression there was no stone, when in reality the bladder had not been opened. Two cases of this kind have come under my notice: in both long gropings occurred, and in one the prostate and neck of the bladder were pushed before the finger, leading to a suspicion of faulty diagnosis. Fortunately the operators did not trust too implicitly to the finger. This risk is mentioned merely incidentally, to show that lithotomy in children is not always completely free from difficulty. In the mean time the sphere of lithotrity has within the past few years been greatly extended, and it is possible that hereafter it may be found preferable in selected cases even in children.

INJURIES AND DISEASES OF THE BLADDER AND PROSTATE.

BY

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WOUNDS OF THE BLADDER.

THE bladder may be rendered physically incapable of retaining urine, by reason of penetrating wounds from without, or laceration of its walls from within the pelvis by fractured bones, or by rupture resulting from sudden compression exercised over it when in a state of distension. These are the more usual causes of this lesion; instances, however, are on record in which it seems to have followed the use of catheters and such like instruments in the male, and of midwifery forceps in the female. Wounds of the bladder are classified as incised, punctured, lacerated, and gunshot wounds.

INCISED WOUNDS.—Owing to the manner in which it is protected by the pelvis, incised wounds of the bladder are of rare occurrence; the late American war failed to furnish an illustration of either this or the following variety. These wounds are generally the result of stabbing; occasionally they are inflicted suicidally; and cases are recorded in which they were made by the patient himself for the purpose of relieving urgent retention.[1] Sometimes these wounds take very remarkable directions.

A case of Mr. Couper's is recorded, in which a sailor's knife, entering at the left buttock, was found to have opened the bladder. Post-mortem examination showed that the weapon, penetrating the gluteal muscles, had cut through a part of the great sacro-sciatic ligament, completely divided the pudic artery and nerve, and one vein, and, opening the bladder at its lower part close to the trigone, had made a wound large enough to admit the tip of the forefinger. The case further illustrates a frequent result of this injury, viz., diffuse inflammation of the cellular tissue of the pelvis, with acute peritonitis.[2]

Where wounds of the bladder have also penetrated the peritoneal cavity, a fatal result has almost invariably followed. The bladder has been unintentionally opened by the knife of the surgeon in the removal of tumors involving the pelvic cavity. The late Dr. Marion Sims recently referred to this accident and its treatment in the following passage:—[3]

The bladder has been wounded in ovariotomy and in extirpation of uterine fibroids. This accident happened once in the hands of the great ovariotomist, Washington Atlee; also in the practice of an eminent surgeon in New York; and it occurred to me in the removal of an enormous uterine fibroma. The bladder was cut across for several inches, as it was extensively spread out over the anterior face of the tumor. The wound of the viscus was closed with fine silver wire. The patient died a few hours afterwards of shock and hemorrhage. Dr. Thomas reports a case where he found the bladder closely attached to the anterior face of an ovarian tumor. There was some doubt about it, and he cut into the bladder, passed his finger in to clear up the diagnosis, and then closed the incision by suture; the patient quickly recovered.

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[1] Lancet, Sept. 4, 1880.

[2] Medical Times and Gazette, June 14, 1879.

[3] British Medical Journal, Dec. 17, 1881.

PUNCTURED WOUNDS are by no means common. They are generally caused by falls from a height, the patient being impaled on stakes, spikes, or other sharp projections. These injuries are usually accompanied by a considerable amount of laceration, which frequently involves the rectum and neighboring structures. When recovery follows, a fistulous opening is often left. Punctured wounds of the bladder are sometimes made by the surgeon with an aspirator-needle or a trocar, for the relief of retention of urine, advantage being taken of the anatomical disposition of the parts to open the viscus without wounding the peritoneum. Consequently this operation is almost invariably practised with impunity, its results thus contrasting with those which usually follow accidental wounds of the organ.

LACERATED WOUNDS, like those of the last variety, are very fatal. When the peritoneum is involved, they are always most serious; other parts in the neighborhood are often injured; and, if recovery takes place, some permanent inconvenience, such as a fistula, is almost unavoidable. The possibility of a wound of the bladder being complicated with fracture must not be lost sight of; and in making explorations with the finger, care should be taken to remove any fragment of bone which may be separated, or is at all likely to become necrosed. Instances are on record where pieces of bone have made their way into the bladder, either by penetration at the time of injury, or subsequently by exfoliation and ulceration, and have formed the nuclei of vesical calculi. Dr. Banister[1] has recently published an account of a patient in whom two vesical calculi, formed on nuclei of bone, resulted from a gunshot wound of the pelvis. The possibility of the bladder being wounded must always be remembered where fracture of the pelvis exists; for in this way it has been both punctured and lacerated with fatal results. Hence, it has become a rule in all cases of injury to the pelvis, when the violence has been considerable, for the surgeon to make a careful examination of the bladder with the catheter, for the purpose of ascertaining this point.

GUNSHOT WOUNDS are, for the most part, met with in military practice, although examples of them are not wanting in civil life. The damage that is thus occasioned, not only to the bladder but to adjacent parts, is often very extensive, and it seems remarkable that recovery should be as frequent as statistics show it to be. In 131 cases of gunshot wound of the bladder, complicated with fracture of one or other of the adjacent bones, collected by Dr. Bartels[2] and quoted by Coulson,[3] there were only 38 deaths; from which we may infer, that these wounds by their extent afford a facility for the escape of urine and pus, which is favorable to recovery, a deduction rendered still more probable by the figures showing double wounds of the bladder to be somewhat less dangerous than single ones. Military experience furnishes many examples in which the bladder and rectum having been shot through, recovery has followed—a result which has been generally attributed by the various observers to the thorough drainage which has thus become a necessary part of the management of these cases. All recorded observations indicate that there is, in this class of injuries, considerable danger of extravasation of urine occurring about the third or fourth day, when the sloughs are beginning to separate. Immediately following upon this we may have peritonitis, cellulitis, or septicæmia, which are frequent causes of death.

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[1] American Journal of the Medical Sciences, January, 1882.

[2] Archiv für klin. Chir., Bd. xxii.

[3] On Diseases of the Bladder and Prostate, 6th ed., p. 86.

Bullets and missiles lodged in the neighborhood of the bladder, have been known to make their way into it by ulceration, and military practice affords numerous examples in which urinary calculi have formed on such nuclei as bullets, pieces of shells, arrowheads, and other miscellaneous objects which entered in this manner.

A wound of the bladder is generally indicated by the escape of urine, more or less bloody, through the laceration, or by the urethra. The position and direction of the opening may assist in the diagnosis. Pain along the course of the urethra, ineffectual attempts to urinate, vesical tenesmus, imperfect priapism, and shock, are other symptoms which are more or less prominent.

In the *treatment* of wounds of the bladder, regard must be had mainly to those circumstances which usually bring about a fatal termination: these are urinary extravasation and peritonitis. No method of treating a wound of the bladder can be regarded as efficient which does not provide for the free escape of the urine, as fast as it is secreted. Where the wound opens into the peritoneal cavity, acute inflammation rapidly supervenes, and it often happens that peritonitis is far advanced before the practitioner has the opportunity of doing anything to avert it. Where there is reason to believe that urine is thus finding its way into the abdominal cavity, the position of the patient is one fraught with the greatest danger. Under the circumstances it becomes a grave consideration whether we should content ourselves with such drainage from the bladder as a catheter would afford, or whether, by a perineal incision, we should not provide an escape for the urine, at least as free as that by which it is finding its way into the peritoneal cavity. The cases recorded by Dr. Walker[1] and Dr. Erskine Mason[2] favor the adoption of the latter proceeding. In both instances there was rupture of the bladder, with peritonitis. In both lateral cystotomy was performed, and both ended in perfect recovery. This is a practice worthy of imitation. I shall presently refer to the circumstances under which it might be deemed desirable to attempt to close an opening in the walls of the bladder, to prevent urine finding its way into the peritoneum.

Extravasation of urine may occur either immediately after the injury, or secondarily, as we have noticed in gunshot injuries, about the time that the sloughs separate. In either instance, but more particularly in the latter, it is to be regarded as a most dangerous complication requiring bold and decisive action. In all cases of wound of the bladder, as long as urine escapes freely, either by the urethra or through the external wound, no anxiety need be entertained on this point. Should, however, the patient have a feeling of chilliness, or a rigor, with sudden diminution or cessation of the flow of urine, and perhaps redness and browniness of some part of the skin adjacent to the wound, there will be much ground for apprehension. A catheter should be at once introduced, either through the wound or along the urethra, by whichever means a flow of urine may be best secured and maintained. Should there be any external indication of extravasated urine, free incisions must be made wherever there is tension, in accordance with the rules of surgery relating to this point. When the extravasation is secondary, it is unfortunately most frequently found taking place where it cannot be seen, into the cellular tissue around the neck of the bladder, giving rise to a very fatal form of pelvic cellulitis. In any case of wound or contusion in the neighborhood of the bladder, should there arise grounds for believing that urinary extravasation into the deeper tissues of the pelvis is going on, a most careful exploration by the finger, not only of the wound but also of the rectum, should be made, and if any indication, such as tension or fluctuation, be discovered, the surgeon should not hesitate to make an incision. Even in the absence of evidence as to the direction urine may be taking, when signs of its extravasation are present at or about the usual time of separation of the sloughs—when it is not infrequent—I do not think that the question of performing perineal cystotomy for the purpose of providing drainage should be set aside. In Dr. Erskine Mason's case, this measure was not adopted till sixty-two hours after the bladder had been ruptured. If no exit for urine is furnished, if it be allowed to collect within the pelvis or become diffused among the tissues, a fatal result is unavoidable. Such a consideration, therefore, determines the expediency of opening the bladder when there are no other means of reaching the point from which the extravasation is proceeding. Pelvic cellulitis occurring under these circumstances, is much more likely on anatomical grounds to extend rapidly backward than to come forward. Hence it is important to recognize its earliest possible manifestations, and to meet them without delay.

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[1] Med. Communications of the Mass. Med. Society, vol. vii.

[2] New York Med. Journal, vol. xvi. 1872.

In gunshot or other wounds in the neighborhood of the bladder, resulting from explosions, careful exploration of the wound must be made with the view of detecting, and if practicable removing, any foreign body which may be lodged within the viscus. The examination of the bladder with the catheter is a proceeding which should not be omitted under such circumstances. In many of the cases in which missiles, incrusted with phosphates, have been extracted by lithotomy, it is probable that in the first instance these were lodged in the vicinity of the bladder, into which they subsequently made their way by ulceration.

Rupture of the Bladder.

This injury is most frequently caused by the application of violence over the region of the bladder when the latter is in a more or less distended condition. Numerous instances are recorded in which the damage has been done in drunken quarrels by blows or kicks, or when in wrestling one man tumbles heavily, falling with his knee on the abdomen of his yielding or perhaps prostrate antagonist. The extreme frequency with which this accident is associated with drunkenness has led to alcoholic influence being included amongst its predisposing causes. Mr. Rivington, in a recent article on this subject,[1] speaks of intra-peritoneal rupture as one of the penalties of drink, and adds to his own testimony that of M. Houel,[2] in the following quotation: "Alcohol has a double influence in predisposing to this injury, for it causes an increased and rapid secretion of urine, and quick distension of the bladder; it also deadens the sensitiveness of its mucous membrane, and the call to micturate is so feeble that it is disregarded by the drunkard, and the distension is allowed to increase."

The bladder has been ruptured, when distended, by violent muscular action, the explanation being suggested, that in these instances the coats of the bladder have undergone some change by which their power of resistance has been sensibly diminished. I have recorded a case[1] in which there were good grounds for believing that the injury was caused in this way:—

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[1] Lancet, June 3, 1882.

[2] Des Plaies et des Ruptures de la Vessie. Paris, 1857.

The patient, a young man, had been suffering from retention of urine for some days. When admitted into the Liverpool Infirmary, he was in a state of collapse from which he never rallied. A catheter was introduced into his bladder immediately after his admission, but only a few drops of blood-stained fluid escaped. At the post-mortem examination, a rupture was found in the posterior wall of the bladder, communicating with the peritoneal cavity. The edges of the opening were covered by lymph, and the rent measured, when not stretched, an inch and a half in length. There were also signs of peritonitis. Though from the history of the patient there was no doubt that he had suffered from prolonged retention, no sensible diminution of the dimensions of the urethra could be discovered.

Dr. Gouley[2] records a case in which rupture of the fundus of the bladder occurred during etherization in a patient suffering from extreme retention of urine, consequent on a complete rupture of the urethra at the bulbo-membranous junction. He says that whilst the anæsthetic was being given the patient became greatly excited, and that during one of his struggling fits the abdominal tumor suddenly disappeared, and the former area of dulness became tympanitic. Dr. T. K. Cruse[3] also furnishes particulars of six cases illustrative of muscular action as effecting this lesion.

It must be remembered that this injury may be occasioned by external violence without its being indicated by any corresponding mark or abrasion, and further, that it may be complicated as well as caused by fracture of the protecting bone. I have known it happen where the pelvis had been broken by a horse falling on his jockey, whilst steeplechasing. These points are not unimportant to recollect, especially under circumstances involving medico-legal inquiries. Men are far more liable to this injury than women. The comparative immunity of the female is explained by Dr. Harrison[4] as being mainly due to certain anatomical peculiarities, having regard to the greater size of the female pelvis and the direction of the bladder. Possibly the shortness and distensibility of the urethra in the female, by permitting a rapid emptying of the bladder on the sudden application of compression—a sort of safety-valve action—has more to do in explaining the rarity of the injury in women than has hitherto been conceded. A reference to any large number of collected cases of rupture of the bladder, seems to indicate that the lesion oftenest occurs in that part of the vesical wall which is least able, by reason of its structural relations, to adapt itself by yielding on the application of any sudden compressing force. Hence the frequency with which the tear is found at the junction of the posterior wall and the fundus.

It is important to notice the kind of wound which is usually met with when a more or less distended bladder gives way under the effect of violence suddenly applied to it. When an examination has been made in cases proving almost immediately fatal, it has been found that the wound has been of the nature of a fissure, varying in extent and direction. In one case which I examined, the opening, though complete, looked like a crack half an inch in length, whilst others have been found nearly two inches long. In the character of these wounds I have never seen anything which would lead me to believe that repair would not be probable on accurate coaptation of their sides with sutures, provided that other circumstances were favorable. When examined after the lapse of some hours from the infliction of the injury, these wounds present varying indications of the acute inflammatory mischief in which they so soon become involved. This was well illustrated by the case to which I have already referred.

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[1] Lectures on the Surgical Disorders of the Urinary Organs, 2d ed., p. 39.
[2] Diseases of the Urinary Organs, p. 245.
[3] Medical Record, Aug. 1, 1871.
[4] Dublin Journal of Medical Science, vol. ix.

The *symptoms* of rupture of the bladder are, in addition to the local signs, those which usually indicate laceration of any other important internal organ. Cases however are occasionally met with in which urgent symptoms remain in abeyance for some time. Mr. Holmes[1] records one terminating fatally, where a man walked to St. George's Hospital complaining of a blow received in the hypogastric region thirty-six hours previously, but exhibiting no distress of any kind ; post-mortem examination showed the existence of an extensive laceration of the bladder. Somewhat similar instances will be found elsewhere narrated.[2] The following passage, from Gross,[3] referring to seventy-eight cases analyzed by Dr. Stephen Smith, bears upon the point now under notice:—

> The primary symptoms are stated to have been severe in fifty-nine of the cases, and it is worthy of note that in forty-three of these the rupture extended into the peritoneal cavity. In nine cases, in seven of which the peritoneum was affected, the symptoms were slight, and in three they were entirely absent. In twenty-eight instances there was from the beginning inability to urinate; in three, on the contrary, the bladder retained its expulsive power. Bloody urine was drawn off in twenty-five cases and clear urine in four. In seven of the cases the patients were able to walk after the occurrence of the injury. Seven of the patients felt a sensation at the moment of the accident as of the bladder bursting. In nearly all there was an absence of evidence of external violence.

The indications of ruptured bladder may be generally stated as pain over the region of the organ, inability to urinate, and more or less collapse followed by signs, local and general, of inflammation. Symptoms such as these, taken in conjunction with the history of the patient, would naturally lead to an examination of the bladder with the catheter. On the introduction of the instrument the bladder may be found absolutely empty, the viscus being felt so firmly contracted on the point of the catheter, as almost to suggest that it had failed to reach it; or a few drachms of blood-stained urine may escape. In some instances the catheter has found its way through the wound, and has thus entered the cavity of the abdomen, from which urine more or less blood-stained has been removed.

These injuries are exceedingly fatal; out of the seventy-eight cases analyzed by Dr. Stephen Smith,[4] in 1851, there were only five recoveries. The consideration of figures such as these indicates that in this particular direction abdominal surgery, which during recent years has made such rapid strides, has yet much to accomplish.

The *treatment of ruptured bladder* must have special reference to the two varieties of this lesion—(1) where the cavity of the peritoneum is opened, and (2) the extra-peritoneal form, where the rupture is in that part of the bladder which is outside the line of reflection of its peritoneal investment. The difference is essentially this: in the former case, the urine and blood pass directly into the abdominal cavity, whilst in the latter they infiltrate the tissues around the bladder, and produce consequences in every respect similar to those observed in urinary infiltration of parts which are more superficial, and where its effects can be seen. With the view of narrowing the principles of treatment, it is important carefully to analyze these two conditions.

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[1] Principles and Practice of Surgery, p. 223, *note.*

[2] Med. Times and Gazette, Sept. 28, 1872.

[3] Practical Treatise on the Diseases, Injuries, and Malformations of the Urinary Bladder, etc., p. 322.

[4] New York Journal of Medicine, N. S., vol. vi.

(1) Where the rupture has extended into the *peritoneal cavity*, I cannot find any evidence to warrant the belief that life has ever been saved without the intervention of surgery. In the few instances in which recovery has taken place, it has been directly traceable to the aid which nature has received from the surgeon's hand.

It will be desirable to ascertain under what circumstances a favorable issue has thus been brought about. There is sufficient evidence to conclude that *catheterization* alone has in some instances been effectual. The cases recorded by Mr. Chaldicott[1] and Dr. Thorp[2] illustrate this. For in these there can be no doubt that large quantities of urine were drawn off from the peritoneal cavity, which, if allowed to remain, would, it is reasonable to suppose, have induced fatal consequences. Dr. Macdougall[3] also records two cases of recovery after rupture of the bladder where catheterization afforded important aid in bringing about recovery. The view taken that the use of the catheter has, in these and other instances, determined the satisfactory result, is strengthened by what has been observed in cases which have terminated fatally. There are reasons for believing that the peritoneum is more tolerant of the presence of healthy urine than we might at first sight be inclined to suppose. In fact we may go further, and say that in these cases the fatal peritonitis set up, is due, not as much to the entrance of healthy urine within the cavity of an uninjured peritoneum, as to the decomposition of the urine which follows its confinement by, or even contact with, tissues more or less disintegrated by violence. Menzel's[4] experiments are confirmatory of this view, as they demonstrate that healthy urine does not, of itself, necessarily cause destruction, and that its effects on the tissues are harmless as long as an escape is provided for it. Subcutaneous injections of fresh healthy urine, made experimentally by Keyes,[5] in man, were followed by no irritation whatever. It is when urine becomes retained, and decomposes, that it manifests its destructive powers upon the tissues with which it is in contact. If no extensive damage be done to the abdominal parietes, if the urine which finds its way into the cavity of the peritoneum be not largely contaminated with blood or other readily putrefiable matter, and if escape, as by catheterization, be provided for urine so effused, peritonitis need not necessarily be provoked. In Dr. Thorp's case, to which reference has been made, in addition to catheterization, washing out of the peritoneum with tepid water, through the catheter, was employed. In the majority of cases of intra-peritoneal rupture of the bladder, one or other or all of these conditions necessary to recovery are usually absent. The effused urine, often largely mixed with blood, comes in contact with bruised and lacerated tissues, and, unprovided with any way of escape, decomposes and gives rise to that rapid and destructive inflammation, probably septicæmic in its nature, which, in spite of all treatment, brings about a fatal termination in the course of a few days.

Again, as already mentioned, cases of rupture of the bladder have been successfully treated by *cystotomy*, and, since these injuries are obviously hopeless if left to themselves, it has been further proposed to perform *abdominal section* for the purpose of allowing the opening in the bladder to be closed with sutures. Mr. Heath[6] and Mr. Willett[7] record cases in which this was done, and though the results were in neither instance successful, this might have been due to the giving way of the sutures which at the post-mortem examination was found to have taken place. In no class of cases have more brilliant results been obtained than in those involving the opening and exploration of the abdominal cavity, and the manipulation of the organs contained in it; and it is reasonable to infer that ruptures of the bladder, now almost always fatal, will some day be brought within the range of this procedure.

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[1] Provincial Med. and Surg. Journal, 1846.

[2] Dublin Quarterly Jour. of Med. Sci., 1868.

[3] Edinburgh Medical Journal, Jan. 1877.

[4] Wiener med. Wochenschrift, Nos. 81–85, 1869.

[5] Van Buren and Keyes, Diseases of the Genito-Urinary Organs, p. 144. New York, 1874.

[6] Med.-Chir. Transactions, vol. lxii.

[7] St. Bartholomew's Hospital Reports, vol. xii.

Fischer, of Buda-Pesth,[1] from a series of experiments on dogs, draws the conclusion that, in wounds of the bladder, success depends almost entirely on the accuracy with which the sutures are placed. He used for this purpose catgut and antiseptic silk, and anticipates a greater success in man by reason of the possibility of retaining a catheter in the bladder. Dr. E. Vincent,[2] of Lyons, in a paper on laparotomy and intra-peritoneal cystorraphy in dogs and rabbits, draws equally hopeful conclusions with regard to wounds of the human bladder.

His method of procedure consisted in opening the abdomen and the bladder; sometimes portions of the wall of the latter were removed. By then temporarily closing the parietal wound, only urine was allowed to remain in contact with the viscera. Subsequently the abdomen was reopened and cleansed, after which the wound in the bladder was carefully closed and the parietal opening again adjusted with sutures. Recovery took place, in rabbits, in cases where the peritoneum had been exposed to the action of the urine for as long as forty-eight hours.

(2) In the second variety of cases the bladder is ruptured *outside the line of its peritoneal investment.* Recovery may occur in spite of the severe nature of the lesion, provided that free vent be given to any urine which is extravasated. The following case may be regarded as typical of this kind of rupture, and illustrates the main principle in treatment upon which it is necessary to lay stress:—

A middle-aged man came under my care, in 1866, for injuries about the pelvis caused by a fall of earth in some dock excavations. There was a fracture of the right ilium, with considerable bruising of the adjacent parts. On passing a catheter, the bladder appeared to be contracted on the end of the instrument, and only a few drachms of blood-stained fluid escaped. The patient remained in a state of collapse all the day of his admission into hospital, and in the evening I found that no urine had escaped by the catheter, which had been retained. The perineum externally was somewhat tumid, but not discolored. On passing a finger into the rectum, a fulness could be felt in front of the bowel, which rendered the line of the prostate quite undistinguishable. Under these circumstances it was thought best to make a perineal incision in the median line, in the direction of the neck of the bladder. This was done, and resulted in the discharge of blood-clots mixed with urine. On examining the wound with the fingers, the prostate was found separated from the underlying structures, and on its under surface could be felt a depression, which proved to be the end of a laceration. Through this extensive incision blood-stained urine continued to flow during the six days that the patient lived. His other injuries added to this one proved too much for him, and he sank from exhaustion on the seventh day. At the post-mortem examination the prostate and neck of the bladder were found completely separated from the parts beneath, and there was a rent in the bladder, commencing an inch behind the prostate and extending forwards through it. The wound did not communicate with the peritoneum, and there were no signs of peritonitis. In addition, there was a comminuted fracture of the right ilium, passing downwards within the brim of the pelvis.

The practice adopted in this case would have probably saved the patient's life had there been no injuries beyond those of the bladder and prostate, as the incision provided a free and direct escape for urine. The reasons for concluding that the bladder was ruptured within reach of the finger, in addition to the evidence afforded by the catheter and the nature of the injury, were, the tumefaction of the perineum and fulness felt in front of the bowel on introducing the finger into the rectum. This, taken in conjunction with the fact that no urine could be obtained by the catheter, justified the conclusion arrived at and the practice adopted. As already stated, this case brings into prominence that principle in treatment which is paramount in the general management of injuries of this kind.

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[1] Trans. International Med. Congress. London, 1881.

[2] Ibid.

There is another part of the viscus which is also uncovered by peritoneum, where we are in the habit of tapping it with impunity. I allude to that portion of it which is situated immediately above the pubis and below the anterior reflection of the serous membrane. Here also it may give way without permitting urine to escape into the abdominal cavity. A typical example of this class (the only one published to my knowledge) was recorded by the late Professor Syme.[1] The course taken by the urine, and the treatment by incision which was successfully adopted, were in correspondence with the analogous features in the case quoted from my own practice.

It has been stated that laceration of the bladder may occur without extravasation of urine ensuing as a consequence. I do not see what positive evidence we can have of this: the nature of the injury, and possibly hæmaturia, might suggest it. Should it be suspected in any case that a partial rupture had taken place, which, by some means or other, such, for instance, as the presence of a clot in the wound, or the exudation of inflammatory material, had become occluded, I should not feel disposed either to pass a catheter, provided that there was no retention, or to retain one. Reliance might under these circumstances be placed on nature completing safely what she had begun so well, aiding her perhaps in keeping the parts quiet, as in the case of wounded intestine, by the administration of opium. Should it be necessary to use a catheter, a soft rubber one should be selected, as answering every purpose, without exposing the patient to the risk of opening up a wound which might be healing by adhesion, or occluded by clot.

In addition to those measures which have been urged as likely to avert peritoneal inflammation by directly dealing with the causes most frequently provoking it, prompt means must, on any signs of its occurrence, be taken to limit its extent and diminish its severity. These consist in the use of soothing applications to the abdomen and the free administration of opium. I have found nothing to give greater relief to the feeling of tension about the parts which these patients generally complain of, than local depletion with leeches, followed by the application of a hot flaxseed poultice. These measures must, however, be regarded as subsidiary to those having for their object the prevention of urine making its way into the peritoneal cavity, or becoming extravasated and retained amid the cellular tissue in relation with the bladder.

Foreign Bodies in the Bladder.

A very miscellaneous collection might be made of various articles which by accident or design have found their way into the bladder. The records of surgery furnish instances of pins, needles, catheters, pencil-cases, tobacco-pipe stems, wires, feathers, shoe-strings, and grass-heads, being so located. When a foreign body becomes lodged in the bladder, one of three things will most likely happen to it: if small, it may be spontaneously expelled during the act of micturition; if it remain, it may possibly form the nucleus of a stone, which will generally be phosphatic; or by exercising pressure on the wall of the bladder, it may cause ulceration, and finally escape into the cavity of the peritoneum, thus permitting urine to become extravasated and causing death by the production of peritonitis in its most intense and fatal form. Any of these three events may happen, the probability of one or another being chiefly determined by the shape and bulk of the article.

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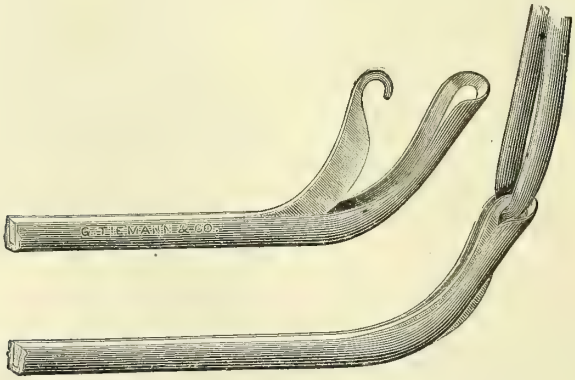
[1] Contributions to the Pathology and Practice of Surgery, p. 332. Edinburgh, 1848.

Symptoms.—The presence of a foreign body in the bladder will be indicated by symptoms similar to those met with in stone: these will be, vesical irritability in varying degree; pain, for the most part after micturition; and probably alkalinity and offensiveness of the urine. Exploration of the bladder with the sound will afford indications of the presence of a foreign body, or of the calculous incrustation in which it is imbedded. Sections of stone removed by lithotomy not unfrequently show the original nucleus to have been some small extraneous body, such as a piece of bone, the head of a pin, or a portion of slate-pencil. When a patient acquaints the practitioner with the precise nature of the accident which has happened to him, the former is prepared to remove the foreign body by means of a suitable instrument; but it not unfrequently happens, especially with females, that deception is practised, and that no explanation of certain bladder symptoms is afforded until a thorough examination is made with the sound. Even then, sometimes, the practitioner has to act on the presumption that the foreign body is a calculus. A case is recorded by Dr. Robert Abbe[1] where he was proceeding to remove what he supposed to be a large calculus, after Bigelow's method, when the discovery was made that the bladder contained a gum-elastic catheter encrusted with phosphates, which had slipped in six months previously. This was successfully removed in two portions, by the lithotrite, and the patient made a good recovery.

Treatment.—In the case of flexible bougies or portions thereof which have thus entered the bladder, their extraction may be effected with a smooth-bladed lithotrite. If not seized by their ends, gum elastic instruments are so yielding that, excepting the larger sizes, they may be generally brought away doubled up, by the exercise of a moderate amount of traction. This has been frequently done with success. Or Mercier's instrument (Fig. 1280), which will permit of the removal of a larger-sized flexible catheter or bougie than can be extracted by the lithotrite, may be used.

Fig. 1280.



Mercier's instrument for removing elastic bougies from the bladder.

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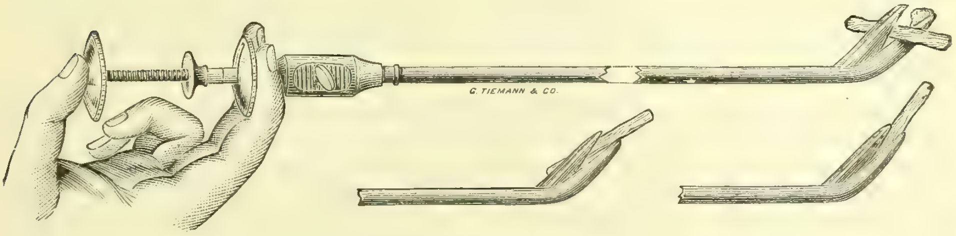
[1] Medical Record, Dec. 24, 1881.

In attempting the removal of inflexible cylindrical bodies from the bladder with the lithotrite, the difficulty is due mainly to the fact that they are generally seized transversely to their long axis, so rendering extraction by this method impossible.

To provide against this, MM. Robert and Collin have devised an extractor (Fig. 1281) having the blades so arranged that when a solid body of this kind is seized, its direction is made to correspond with that of the instrument as shown in the figure. In the absence of such an instrument, it must not be forgotten that much may be done to favor the possibility of extracting an inelastic cylindrical body with the ordinary lithotrite, provided that this be systematically used with the object of arriving at one or other extremity. In this way I succeeded in withdrawing a pencil-case three and a half inches long, from the bladder of a patient who alleged that it had been passed down the urethra on the previous night, whilst he was in a state of intoxication, by a woman of the town. He recovered without a bad symptom.[1]

Fig. 1281.



Robert and Collin's instrument for removing foreign bodies from the bladder.

Lithotrity has been employed for the removal of foreign bodies together with the incrustations which have formed upon them. In selecting this method, regard must be had to the probability of the foreign body being of such a nature as to be removable in this way. I know of this procedure having to be abdandoned for lithotomy, in a case where the nucleus turned out to be a hair-pin, in which the blades of the lithotrite had become entangled. When there is no other alternative, *lithotomy* will be resorted to; this operation has on many occasions, under these circumstances, been successfully practised. A case is recorded by Mr. J. W. Baker, of Derby, in which a piece of bougie remained in the bladder for five years, and was then removed, encrusted with phosphates, by lithotomy.[2]

The female bladder is also occasionally found to contain various foreign bodies; of these the ordinary hair-pin is perhaps the most common. On account of its two prongs and shape it is not always easy of extraction. In a case of this kind which I have recorded,[3] there was some tumefaction to the left of the symphysis pubis as if an abscess was impending. It is probable that the pin might have been expelled in this way had not its removal been effected by surgical interference. As in cases of stone, operations on the female bladder, where the urethra is incised, are apt to be followed by permanent incontinence of urine; rapid dilatation of the canal should be employed in preference whenever it is practicable.

In regard to the nature of the concretion found on foreign bodies in the bladder, it may be said that any substance other than the earthy phosphates, is extremely rare.

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[1] Op. cit. p. 185.

[2] British Medical Journal, Dec. 5, 1874.

[3] Op. cit. p. 189.

It will be proper to mention here that a few cases are on record where most exceptional substances have found their way into the bladder. Ovarian and dermoid cysts have been known to empty themselves into it. A case is recorded by Sir Henry Thompson[1] in which some fœtal remains were removed from this organ. Then again instances are occasionally met with where fecal matters and flatus have been discharged into the bladder, often occasioning much distress. For the most part these cases have been due to cancerous ulceration between the bladder and intestines, and can only be temporarily remedied by colotomy. For these symptoms alone, resort has frequently been had to this operation with the greatest relief to the patient.

It is alleged that in addition to the modes mentioned, foreign bodies may find their way into the bladder from the intestines by ulceration.

The following case is recorded by Mr. A. Roberts, of the Sydney Hospital, New South Wales.[2] The patient, aged 47, had swallowed a piece of slate-pencil two and a quarter inches long, which was subsequently successfully removed by lithotomy. Commenting on this case, the author says: "I have left no stone unturned to elucidate the truth in this very interesting case, and can only state that, after much hesitation, I have arrived at the conclusion that the pencil was swallowed by the mouth, and made its way by inflammation and ulceration into the bladder." As exemplifying a more probable mode by which a foreign body may enter the bladder, and form the nucleus of a stone, a case recorded by Mr. A. J. Cumming[3] may be mentioned, in which the patient had been treated for vesical disease. At the autopsy, the bladder was found to contain a large stone, the nucleus of which was a pin. The pin had evidently made its way from the appendix vermiformis into the bladder, and had left a fistulous communication through which also worms had been enabled to crawl into the viscus. [A precisely similar case was recorded by Dr. Kingdon.[4]]

MALFORMATIONS AND MALPOSITIONS OF THE BLADDER.

Of the various deformities which come under the notice of the surgeon, it will be generally admitted that, in the production of discomfort and in the denial of the gratification of natural desires, none can compare with those which will now be brought under consideration. These malformations, for the most part, occur in male subjects, often well developed in other respects.

COMPLETE ABSENCE OF A BLADDER, or of an independent receptacle for urine, is occasionally, though very rarely, met with. Under these circumstances the ureters open by the umbilicus, in the urethra or vagina, or into the rectum. It is possible that this last-mentioned condition first suggested the expediency, in extroversion of the bladder, of endeavoring by operation to make the ureters discharge into the gut, and thus carry the urine into the rectum. Where the bladder has been completely absent, I am not aware of attempts having been made, with any degree of success, to construct one; nor can I, after a careful examination of the literature relating to the subject, suggest any surgical procedure which would be at all likely to ameliorate so unfortunate a condition.

Dr. Oliver[5] records a case of absence of the bladder in a woman who died at the age of fifty-three. Throughout the whole of the illness which proved fatal to her, frequent micturition is reported as being one of her symptoms. At the post-mortem examination, the ureters, only one of which was pervious, were found to open into the urethra, at about $1\frac{1}{2}$ inches from the meatus. The pervious ureter was largely dilated, being described as like a coil of child's small intestine, contracted above at its connection with the kidney, and constricted below before joining the urethra. Dr. Oliver remarks, "a certain amount of natural or spasmodic contraction at this point would prevent a continual dribbling away of urine, and thus allow more comfort to the patient."

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[1] Lancet, Nov. 22, 1863.

[2] Med. Times and Gazette, July 30, 1859.

[3] British Medical Journal, Oct. 22, 1881.

[4] Trans. Provinc. Med. and Surg. Association, vol. x. p. 198.

[5] Lancet, Dec. 6, 1879

I refer to this case, and take it in conjunction with what is sometimes observed as a consequence of stricture or prostatic obstruction of long standing, where the ureters may almost be said to have become subsidiary bladders, as suggesting another direction in which something might be done to render less intolerable the condition of persons laboring under this deformity.

TWO-CAVITY BLADDERS, or, more correctly speaking, bladders with a septum, have been described. Other instances, in which a bladder has had subsidiary bladders connected with it, have also been referred to as varieties of malformation. These, however, are for the most part the result of disease, and will receive consideration hereafter, when sacculation of the bladder is discussed. Under this heading I may mention a remarkable case of double bladder, which is recorded by Dr. A. P. Smith, of Baltimore.[1] The patient complained of irritation, in connection with micturition. On examining him it was discovered that he had a double penis, with bladders to correspond, and his symptoms were explained by the presence of a stone in one of the bladders, whilst the other was healthy. Lithotomy was successfully performed. Van Buren[2] describes a similar deformity.

EXSTROPHY OR EXTROVERSION OF THE BLADDER.—I will now proceed to notice the commonest form of abnormality, *extroversion of the bladder*. Here not only does the bladder protrude, in appearance like a fungating mass, through the abdominal parietes, but its anterior wall, as well as the pubic symphysis, are both wanting. Below the bladder, in the male, a short penis usually projects, on the dorsum of which is a shallow gutter representing the uninclosed urethra. From the orifices of the ureters, which can be plainly seen at the lower part of the mucous surface, the urine constantly drips over the scrotum and adjacent parts, excoriating the skin, saturating the clothes of the unfortunate victim, and giving rise to a most unpleasant urinous smell. There are greater and lesser degrees of the deformity. The remaining parts of the generative apparatus—viz., the prostate, vesiculæ seminales, and testicles—are usually present, but in a somewhat rudimentary condition. In such persons an inguinal hernia on one or both sides is commonly met with. Sexual desire is more or less present, with, of course, incapacity for its natural gratification. In some recorded cases this has greatly added to the misery of the patient, and has suggested the propriety of emasculation by removal of the testicles. In the female the nature of the deformity is analogous, but instances of it are much less frequently met with than in the male.[3]

Treatment.—The operations which have been devised for the purpose of remedying this distressing condition may be divided into two classes: one, having for its object the diversion of the stream of urine into the lower bowel, so as to utilize the rectum as a common cloaca; the other, or plastic method, in which the scrotal and abdominal integuments are used not only for the purpose of covering in the protruding bladder, but further with the view of providing some sort of receptacle for the urine. From a careful study of the results which have accrued from the practice of both these methods, it seems probable that most relief will eventually be obtained by their combination. One or other can only be regarded as a partial proceeding, for in the former no provision is made for the covering and protection of the mucous membrane, whilst in the latter, however perfectly integument from neighboring parts may be arranged so as to complete a receptacle for the urine, still in the absence of any valvular or muscular arrangement by means of which the contents may be retained or expelled at will, a state of incontinence must remain, which is only imperfectly provided for by artificial contrivances.

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[1] Transactions of the Medical and Chirurgical Faculty of the State of Maryland, April, 1878.

[2] Op. cit. p. 5.

[3] In an interesting account of the dissection of a specimen of this malformation, McWhinnie has referred to some important physiological experiments which the nature of the deformity permitted; amongst these may be mentioned, as appropriate to the subject-matter of this article, that asparagus was found to affect the odor of the urine in eight and a half minutes, and turpentine in four and a half minutes. (London Medical Gazette, March 1, 1850.)

It will be proper now to consider more in detail what may be regarded as the typical procedures in each of the two classes, which represent the operative means at present at our disposal for remedying the various degrees of extroversion.

The only instance I know of in which the attempt to divert the urine into the rectum was to any extent successful, is one recorded by Mr. Simon,[1] who, in this case, by means of threads passed from the ureters into the bowel, succeeded in establishing a free communication between them. Although a considerable quantity of urine made its way by the new route into the rectum, a portion of it escaped as before; nor does it appear to have been possible to prevent this. Hence the operation can only be regarded as having been partially successful.

For a similar object a seton was used by Mr. Lloyd,[2] but with a fatal result, from injury to the recto-vesical pouch of peritoneum. With the view of avoiding as far as possible, the last-mentioned risk, Mr. Holmes[3] has proposed establishing the communication by means of a pair of screw-forceps, by which pressure can be exercised on the bladder and rectum. By screwing up the instrument, these two points are brought together, through the compression of the intervening tissues, and in this ingenious way an opening is established by the formation of a slough. In the case, however, in which Mr. Holmes adopted this method, there seems to have been a difficulty in keeping the new route open, and urine continued to flow over the pubes in considerable quantities.

More recently, Mr. Thomas Smith, of St. Bartholomew's Hospital, has recorded a case[4] in which he attempted to establish a permanent connection between the ureters and the posterior surface of the colon. Though with considerable difficulty, he succeeded in effecting the communication on one side, but when making a similar attempt on the other, a fatal result ensued. The following passage from Mr. Smith's communication, having a general bearing upon this class of operations, may be quoted:—

> The kidneys seem to have been the organs to suffer by the operation, the secreting structure on one side, the left, being entirely removed by suppuration, while the function of the right kidney was so quickly and seriously affected as to put an end to life within three days. The more rapid implication of the kidney in my own case was probably due to the more direct communication between the cavity of the bowel and the pelvis of that organ. The whole length of the ureter intervened in Mr. Simon's case between the bowel and the kidney, whereas in my patient there were but two inches of ureter. In connection with this subject, it may be worth considering how far the function of the kidney might be influenced by the introduction of intestinal gas

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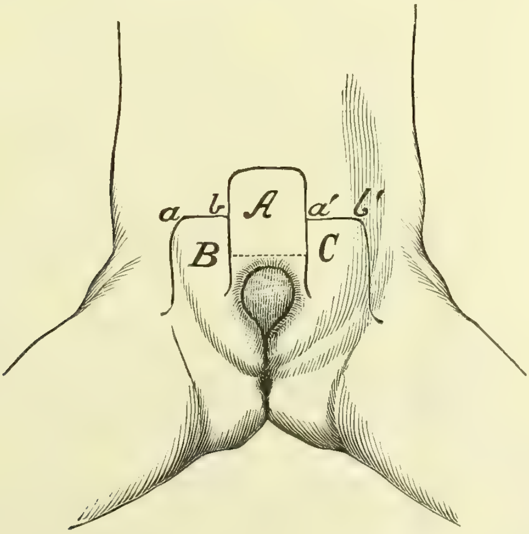
[1] Lancet, vol. ii. 1852.
[2] Ibid., vol. ii. 1851.
[3] Surgical Treatment of Children's Diseases, p. 148.
[4] St. Bartholomew's Hospital Reports, vol. xv.

to its pelvis. In my own case, when the colon was distended by flatus, one could feel certain that gas would find its way into the ureter, and so into the pelvis of the kidney.

Assuming that it is possible to establish the most complete and satisfactory communication between the rudimentary bladder, or the ureters, and the bowel, the degree of comfort which this arrangement would confer on the patient still remains undetermined. Whether the rectum is capable, in the human subject, of adapting itself to the twofold office of bladder and bowel is, to say the least, problematical. In a case where the ureters opened into the rectum, the patient suffered from constant diarrhœa and irritation induced by the passage of the urine into the bowel.[1]

We may now proceed to consider the second class of operations which have been practised, namely, those of a distinctly plastic character. The first successful operation of this kind was performed in 1858, by the late Professor Joseph Pancoast, of Philadelphia,[2] who used two reversed skin flaps, taken from the groins, and turned with their epidermal surfaces towards the vesical mucous membrane. In England, Mr. Timothy Holmes[3] soon followed in the same direction, and subsequently Mr. John Wood,[4] of King's College, further added importantly to our resources in the devising and adjusting of flaps for both sexes. Referring to these operations, Professor Gross considers that Wood's plan is best adapted for the female, and that employed by the late Dr. Maury[5] (which was essentially that recommended by Roux, of Brignoles) for the male.

Fig. 1282.



Wood's operation for extroversion of the bladder. (After Ashhurst.)

For the performance of Wood's operation (Fig. 1282), an umbilical flap, *A*, is turned down over the bladder, the groin flaps, *B* and *C* being superimposed and joined together by their free borders, *a b*, *a′ b′*, so as to meet in the middle line. The details of this operation may be best studied by referring to Mr. Wood's original communication on the subject. Maury's operation is thus described by Gross:[1]—

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[1] Philosophical Transactions, vol. vii.

[2] North American Med.-Chir. Review, 1859.

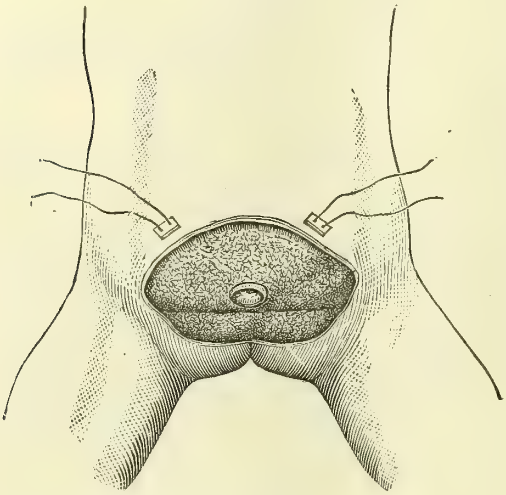
[3] Op. cit., p. 149.

[4] Med.-Chir. Trans., vol. lii.

[5] American Journal of the Medical Sciences, July, 1871.

> A flap is taken from the perineum and scrotum by carrying a curvilinear incision from the outer third of Poupart's ligament, across the middle of the perineum, to a corresponding point on the opposite side; the flap is dissected up carefully, to avoid wounding the testicles, or hernia should the latter be present, until the root of the penis is reached, when that organ is slipped through a small opening made for it in the centre of the flap, by which means the urine issues without coming in contact with the wound. A curvilinear incision is then carried across the abdomen, and a short flap dissected up for about an inch; under this, the scrotal flap, its cutaneous surface having been vivified, is slid, and attached by several points of a modification of the tongue and groove suture of Professor Pancoast. (Fig. 1283.)

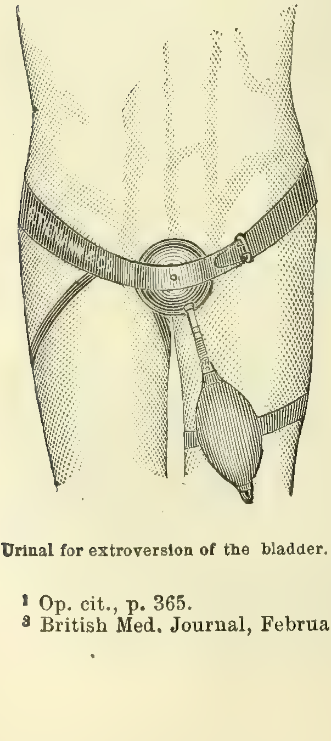
Fig. 1283.



Maury's operation for extroversion of the bladder.

In a recent communication on the subject, Mr. Rushton Parker, of Liverpool,[2] whilst advocating in principle Wood's method of operating, lays stress upon certain improvements suggested by Dr. Greig Smith, of Bristol,[3] which he considers contributed much to the success of the operation in the cases which he records. These are as follows: (1) The adoption of a pear-shaped or bellows-shaped flap as an anterior lining, not only to the bladder, but also to the simultaneously completed dorsal aspect of the urethra, and the covering of the latter or urethral portion of the flap with a strip of skin obtained by bringing out the penis and prepuce through a hole in the scrotum. (2) The better-planned, and more thoroughly completed attachment of the covering flaps without gaps, and the substitution of "relaxation-sutures" and interrupted "edge-sutures" for hare-lip pins and twisted sutures. (3) The adoption of boracic-acid dressings, whereby decomposition is prevented, and the inevitable urinary infiltration rendered innocuous; consequently, primary union being extensively obtained, the duration of the treatment is limited to the shortest possible period. In Mr. Parker's cases, where union by first intention occurred almost completely, the boracic dressings were kept constantly wet and fresh by the use of a bath in which the patient lay throughout the treatment, the bath being so constructed that the hips were kept immersed in warm boracic lotion whilst the limbs and trunk remained dry.

Fig. 1284.



Urinal for extroversion of the bladder.

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[1] Op. cit., p. 365.

[2] Liverpool Med.-Chir. Journal, January, 1882.

[3] British Med. Journal, February 7 and 28, 1880.

The patients all slept as well in the bath as they had previously done in bed.

After the operation, a properly constructed urinal will be required, at all events during the daytime. Something similar to that represented in the accompanying illustration (Fig. 1284) will be found convenient. At night, however, a simple appliance such as a sponge, secured to the perineum, may be substituted, and thus the skin may be relieved from the constant pressure of the apparatus.

Though a plastic operation may not be successful in furnishing a reservoir for the urine, capable of being acted upon at will, yet the providing of a protection for the exposed mucous membrane, as well as a means whereby the urine may be more readily collected, are results which can be promised, and which warrant the performance of an operation based upon the principles to which reference has been made.

[Though, upon the whole, satisfactory in their results, these plastic operations for extroverted bladder are not free from risk, 100 cases to which the editor has references having given at least 20 deaths.]

Patent Urachus.—In the early fœtus, the sac of the allantois consists of an extra-abdominal and an intra-abdominal portion, which communicate with each other through the umbilicus. Soon the extra-abdominal part disappears, the lower half of the intra-abdominal segment becomes the urinary bladder, and, ordinarily about the thirtieth week of intra-uterine life, the upper half becomes obliterated and forms a fibrous cord, the urachus, passing from the apex of the bladder to the umbilicus. Occasionally, however, it remains open, and in such a case the patient is liable to the discharge of urine from the navel, and to the formation of a urinary fistula which may suppurate and lodge urinary concretions. Patency of the urachus is most frequently observed in connection with some obstacle to micturition.

Treatment.—To remedy this defect, various means similar to those employed in the treatment of other fistulæ have been recommended, including the application of the cautery and plastic operations. Care must in the first place be taken to remove any hindrance to micturition which may exist, such for instance as that occasioned by a contracted meatus, a phimosis, or a urethral calculus.

A case is recorded by Dr. Cadell,[1] in which, in a female child, a cure was attempted by temporarily establishing a state of vesical incontinence by dilating the urethra. Mr. Paget, of Leicester,[2] records a case in which he extracted through the urachus a vesical calculus which had formed on a hair; he subsequently succeeded in closing the opening by paring the edges and approximating them with sutures.

Hernia of the Bladder.—Amongst the rarer varieties of hernial protrusion is that in which the bladder forms the whole or a part of the tumor: in some instances it is accompanied by intestine, behind which it usually lies. In the male, cystocele most frequently occurs in the inguinal canal; it may be either complete or incomplete, or may even extend like an intestinal hernia into the scrotum. In the female the displacement is most commonly vaginal. As the bladder is only partially covered by peritoneum, it can be readily understood that when it becomes thus displaced, the protrusion is, for the most part, destitute of a sac. Fortunately, however, cystocele differs from other herniæ in seldom rendering necessary any surgical operation, and then only for the purpose of meeting some complication to which the normally located viscus is also exposed. I am not aware of an instance of strangulation of the bladder having taken place, such as to require a surgical operation for its relief.

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[1] Edinburgh Medical Journal, 1878.

[2] Med.-Chir. Transactions, vol. xxxiii.

Some remarkable examples of cystocele are recorded: in one, narrated by Mr. Clements,[1] the whole bladder had passed out through the abdominal ring into the scrotum, where it formed a tumor of large dimensions capable of holding two quarts of urine. Cases are reported in which a cystocele occasioned retention of urine and cystitis, as well as others in which calculi were found.

The comparative rarity of this affection has led to some errors being committed both in diagnosis and treatment, which have resulted in serious consequences. The possibility of its being mistaken for a hydrocele must not be overlooked. Pott[2] records a case in which he cut into a cystocele on the supposition that he was dealing with a diseased testicle, and there are other instances in which the tumor has been mistaken for abscess or inflammatory enlargement about the groin.

The *diagnosis* of a cystocele is not attended with much difficulty under ordinary circumstances. It is a soft, elastic, fluctuating tumor, varying in size in accordance with the amount of urine contained, and capable of being emptied by pressure, on the application of which a desire to micturate is experienced. In Mr. Clements's case the patient could not pass water without first raising the rupture towards the belly and then rolling it about, when urine would pass freely, though in small quantities at a time. In the female, the protrusion, as already mentioned, is usually vaginal, occupying the anterior wall of the canal, and being commonly spoken of as a prolapse of the bladder. It occurs in females of a lax habit, who have suffered from prolonged leucorrhœal discharge, but oftener it is one of the results of the child-bearing period, being probably occasioned by some over-stretching of the parts in labor, or by subsequent subinvolution of the vaginal walls. Instances are recorded in which it has produced considerable embarrassment during delivery; when it has been occasionally punctured, under the belief that it was a cyst of the ovum or a hydrocephalic head.

The *treatment* of this displacement is in principle similar to that applicable to other forms of hernia; it is either palliative or radical: the former division includes the use of supports or trusses adapted to the position and nature of the protrusion; the latter, the prevention or limitation of the displacement by some plastic operation. In the female, the use of astringent lotions and the wearing of a suitable pessary are generally sufficient to prevent the occurrence of any considerable inconvenience. For the relief of the more unmanageable cases of vaginal cystocele, various expedients have been adopted. These consist for the most part in the removal of portions of the vaginal wall, and the drawing together by sutures of the edges of the wound, with the view of securing a narrowing of the canal. Dr. Marion Sims and Mr. Baker Brown both described operations of this kind, termed elytrorraphy, which have been followed by good results. In the last place, it must be mentioned that cases are on record in which the prolapse has been so unmanageable, that almost complete occlusion of the vaginal orifice by paring the labia and uniting them with sutures has been found necessary for success.

INVERSION OF THE BLADDER.—This term is used to describe a condition—exceedingly rare—in which the viscus is turned inside out and protrudes through the urethra. It is only met with in females, and is generally partial, seldom complete. Dr. Gross[3] refers to only seven cases of the latter variety, indicating the exceptional character of the displacement. [An eighth case, complicated with prolapsus of the rectum, in a child sixteen months old, came under the editor's observation in the spring of 1884.] In a paper on this subject, Mr. John Croft[1] briefly describes the appearances and symptoms of the affection, as follows: "A small, pyriform, red, vascular, elastic tumor, situated between the labia, below the clitoris, and in front of the vaginal orifice; the urethra not distinguishable; the ureters exposed, and perhaps distilling urine; a history of more or less incontinence previous to the appearance of the tumor; these symptoms should lead one to recognize an *inversio vesicæ*, and to distinguish such an affection from a solid polypoid growth."

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[1] Observations in Surgery and Pathology. London, 1832.

[2] Philosophical Transactions. London, 1764.

[3] Op. cit., p. 349.

In the case recorded by Mr. Croft, rupture of the inverted bladder, and escape of peritoneal fluid took place owing to the violent expulsive efforts set up by the protrusion. In spite of this serious complication, after return of the bladder had been effected by manipulation under chloroform, the patient made a good recovery, which, from a subsequent report, appears to have been permanent.

In a similar case recorded by Dr. Lowe,[2] it is stated that treatment by actual cautery was employed, and occupied eleven months; there was no relapse, but some degree of incontinence remained.

Sufferers from this displacement have, on account of its rarity and resemblance to a polypoid growth, been exposed to some risks connected with a false diagnosis. Mr. Crosse,[3] under the impression that the inverted viscus was a vascular tumor, was contemplating its removal by ligature before he discovered its true nature. The affection appears to be due, not to any malformation of the parts, but to a condition of relaxation as a predisposing cause, and to some violent expulsive effort, attendant on micturition or the discharge of feces, as the exciting cause.

Treatment.—The individual cases to which reference has been made indicate what may be done towards remedying this extremely rare displacement.

Cystitis.

Cystitis, or inflammation of the bladder, is met with in varying degrees of severity, being usually described as acute or chronic; but between these extremes all shades of the affection are to be seen, and hence this classification must only be accepted as representing typical examples.

Acute cystitis may be provoked in any of the following ways, which are selected as examples of causation, rather than as including all the circumstances under which the disease may arise: by extension of inflammation from some adjacent part, as in gonorrhœa; by changes in the urine resulting from its decomposition, as in retention from stricture; by injuries of various kinds, not excepting surgical operations; by the irritation caused by fragments of calculi; and by the presence in the urine of certain elements foreign to its composition, of which those derived from cantharides, oil of turpentine, and other stimulating drugs, furnish illustrations.

In reference to the causation of cystitis, it has been well remarked by Dr. Owen Rees,[4] that "it may indeed be regarded quite as an open question whether we have a right to believe in inflammation occurring in the bladder, irrespective of mechanical cause or the presence of some chemical irritant, and otherwise than as the effect of long-continued sympathetic irritation."

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[1] St. Thomas's Hospital Reports, New Series, vol. ii.

[2] Lancet, March 8, 1862.

[3] Transactions of the Provincial Medical and Surgical Association, New Series, 1846.

[4] Croonian Lectures on Calculous Disease, p. 47.

The most acute form of cystitis is that occasionally seen in connection with surgical procedures having for their object the removal of stone from the bladder; it may even follow the preliminary examination known as sounding, by which the presence of a calculus is determined. The production of cystitis after lithotrity has been attributed by Professor Bigelow, not as much to damage inflicted by the presence of the lithotrite within the bladder, as to the retention, as foreign bodies, of fragments of the stone. With the view of removing so fruitful a cause of inflammation, in connection with these operations, Professor Bigelow[1] has demonstrated the feasibility of withdrawing at one sitting the whole of the fragments by sufficient trituration and suitable aspiration; with the result of considerably diminishing the risk of cystitis. Not only has he thus, to a large extent, succeeded in ridding the operation of its chief source of danger and failure, but he has proved the safety with which lithotrity, in suitable cases, can, like lithotomy, be completed at one sitting. Incidental allusion is made to this subject here, only as bearing on the causation of cystitis.

Additional interest has recently been attached to the production of cystitis and ammoniacal urine, by the discovery of bacteria in fresh urine, under apparently inexplicable circumstances, as illustrated by Dr. W. Roberts.[2] Clinically, it is important to remember that very active cystitis has been provoked by the use of unclean instruments, such as catheters; and, further, that certain drugs capable of controlling it, as for example the salicylates and quinine, probably owe this power to their action as bactericides.

Symptoms.—Acute cystitis, however provoked (and it can never be regarded as spontaneous in origin, or idiopathic), usually presents the following symptoms, of which the local are the first to appear. There is deep pain, increased on pressure, immediately above the pubes; micturition becomes frequent, and is most distressing, a few drops of urine being the only result of prolonged and spasmodic efforts. The limited area of the tenderness is sufficient, in conjunction with the vesical irritability, to indicate the organ implicated. The urine is high-colored, and sometimes tinged with blood. In proportion to the severity of the inflammation, so do the neighboring parts sympathize. There is rectal tenesmus, and a distressing feeling of fulness about the perineum, as if there were something which ought to be expelled. Subsequently the urine is found to be loaded with lithates and mucus, and ultimately it becomes ammoniacal. The constitutional symptoms are those indicating inflammation of a vital organ. The attack is usually ushered in by rigors, or a feeling of chilliness, and the symptoms of an acute febrile attack soon supervene, unless the cause of the inflammation is speedily removed; as, for instance, fragments of stone left behind in the bladder after the operation of lithotrity. These symptoms rapidly assume a fatal character; the tongue becomes brown, the pulse thready, and the skin clammy, and death occurs within a week from the commencement of the attack.

In the acuter forms of cystitis, the mucous membrane is the part chiefly involved; after death this is found deeply injected, with here and there patches of a still deeper hue, as if from submucous hemorrhages.

Occasionally the mucous membrane of the bladder, when inflamed, throws out an exudative material, which has suggested the name of diphtheritic or croupous cystitis. Casts of the vesical cavity may in this way be formed, and cause retention, necessitating the operation of tapping. Diphtheritic inflammation of the bladder has been noted as occurring in association with the presence of diphtheria elsewhere. Billroth[1] says that he has only met with this condition as a secondary affection, consequent on fracture of the spine, rupture or stricture of the urethra, or hypertrophy of the prostate.

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[1] Litholapaxy, or Rapid Lithotrity with Evacuation.

[2] Brit. Med. Journal, October 15, 1881.

Both sloughing and abscess are sometimes, though rarely, met with as results of cystitis. Such destructive lesions as these are, as Charcot suggests, due, not as much to the intensity of the inflammation, as to the presence of causative or at least of coexistent changes in the spinal cord, particularly in the gray matter.

Treatment.—The treatment of the various degrees of cystitis designated as acute, may be briefly summed up as follows. The exciting cause must, if possible, be removed. Fragments of stone, pent-up gonorrhœal matter in the urethra or in its lacunæ, and urine made offensive by retention, or by the irritating foreign elements present in the excretion and derived from certain drugs in excessive doses, are all excitants of cystitis, which either may be removed, or the effects of which may be mitigated. The retention of a catheter under these circumstances can do no good, unless, from paralysis or otherwise, the bladder is incapable of voiding its contents. I have sometimes found the injection and withdrawal of small quantities of tepid water not only soothing, but efficacious in removing possible sources of irritation. As a rule, local depletion by leeches, above the pubes or over the perineum, speedily relieves the feeling of tension of which patients complain at the onset of the disorder. Hot applications in the form of fomentations and hip baths, are also indicated. Among topical remedies which give the greatest relief, I believe that nothing can compare with hot bran poultices, well saturated with laudanum and laid over the abdomen. These are extremely light, and are very soothing and relaxing to parts invariably complained of as feeling tense. Opium in the form of suppositories will also be required. It is important that the patient should partake freely of diluent drinks and pleasantly flavored alkaline medicines, which quench thirst and are grateful to the palate. Hyoscyamus in full doses has long been regarded as probably the most useful, single remedy in inflammatory affections of the bladder.

CHRONIC CYSTITIS.—Inflammation commencing in an acute or subacute form, not unfrequently merges into the chronic variety of this disorder, which is extremely common.

Causes.—Vesical catarrh is a constant complication of various disorders of the genito-urinary organs. The kidney, or rather the digestive apparatus, is frequently responsible for its origin: we see this illustrated in certain gouty affections, in which the urine is rendered intensely irritating by the crystals it contains; and again we have cystitis provoked by the passage into the bladder of urine largely charged with pus derived from a suppurating kidney. Passing to the bladder itself, we find instances of inflammation produced by the presence of stone, by the formation of pouches or sacculi, in which urine lodges and decomposes, by paralysis from spinal disease, and by the irritation occasioned by intravesical growths. The enlarged prostate is probably the most frequent cause of chronic cystitis, as it leads to either partial or complete retention and urinary decomposition. In this way cystitis may be maintained almost indefinitely.

Coming to the urethra, the gonorrhœal poison is a frequent excitant of inflammation in the viscus behind it; whilst stricture, in the double capacity of a local irritant and a source of retention, is largely and very evidently responsible for the production of this affection. To these and like causes of irritation of the urinary reservoir, we must add some of the means which are used for their relief, where certain ill effects unfortunately result from well-intentioned efforts. I refer to the production of cystitis by operative measures, such as the passage of catheters, bougies, sounds, and lithotrites into the bladder; and to the use or abuse of injections in potent forms for the treatment of disorders of the urethra. Here then we have such a multiplicity of causes of chronic cystitis, that we shall do well never to commence its systematic treatment without feeling that there is a cause to be determined, if success in treatment is to be attained.

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[1] Clinical Surgery, New Sydenham Society's Translation. 1881.

The mischief produced by this affection is by no means limited to the mucous membrane of the bladder, though this is chiefly involved. The urine becomes loaded with the excessive secretion of the membrane, a condition of alkalinity of the urine is produced, ammonia is generated and evolved, and more remote changes, not only in the bladder but in other organs, follow. These changes have reference principally to the kidney, and to the formation of vesical calculus. Chronic pyelitis is a by no means uncommon accompaniment of long-standing cystitis, and there is nothing remarkable in the fact that these two conditions should so frequently coexist. When the intensely irritating nature of the compounds into which urine is converted is considered, as well as the constant evolution of volatile ammonia which is going on in the central reservoir of the urinary apparatus, there can be no difficulty in understanding the connection between the two. These secondary changes in the kidney are undoubtedly the most serious of the local results following protracted inflammation of the bladder.

The effects of what has been spoken of as the ammoniacal fermentation of urine are, however, in some cases by no means limited to the kidneys. General symptoms, which include pains about the head, dryness of the tongue, nausea, hæmaturia, and diarrhœa, are directly traceable (a point on which Billroth lays stress) to a condition of ammonæmia which often attends chronic cystitis.

The relation of cystitis to the formation of vesical calculus cannot be passed by without notice. That a certain degree of irritation, if not of inflammation, is a constant factor in stone production there can be but little doubt. Let us observe what follows the excitation of inflammation of a moderate amount in the bladder, by the introduction into it of an extraneous substance. A piece of bougie may thus become accidentally lodged: cystitis is produced, the urine is rendered alkaline, and phosphates are thrown down in abundance, and aggregated around the foreign body. As long as this remains in the bladder, the cystitis continues, and the concretion increases in size; until eventually the portion of bougie, being completely covered in, ceases itself to play any part in the process of stone formation which is in progress. And what is true of phosphatic calculi, is equally true, though in a somewhat different sense, of calculous concretions of other chemical composition. The latter do not necessarily arise out of the products of urinary decomposition which cystitis provokes, but when certain constituents of the urine are present in excess, such as uric acid and urates in the gouty, or oxalates in the dyspeptic, the mechanical irritation which these salts may create leads to the pouring out of mucus from the vesical membrane in greater abundance than is natural. Thus a colloid is provided, which plays an important part in the process of stone formation. In corroboration of this view I will quote the following passage from Dr. Vandyke Carter's work:—[1]

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[1] The Microscopic Structure and Mode of Formation of Urinary Calculi, p. 39.

An excess of mucus, perhaps altered in character, in the urinary passages, or the effusion of albumen, fibrine, or blood, and the like, say from congestion of the kidneys or from irritation of the urinary tract, would furnish a colloid medium with which uric acid, the urates, or oxalates—themselves, perhaps, in excess—could combine in the manner before described; should there happen, also, an undue concentration or special loading of the urine, the probabilities would be strengthened that to some illness—fevers of various kinds, ague, or an attack of cholera, renal congestion or inflammation—would be correctly dated the commencement of a calculus. It must also be assumed that the continued growth of a stone is dependent upon the presence of organic matter, and this at every stage.

Sufficient importance has not been attached to chronic cystitis, in its relation to structural kidney disease—surgical kidney—as well as to the part it plays in the formation of stone. No description of it can have any claim to completeness, unless reference is made to these as amongst its most common results.

Symptoms.—The symptoms of chronic cystitis vary both in kind and degree; in the slighter cases there is irritability of the bladder, with an increased deposit of flocculent mucus, in which pus-corpuscles are entangled. This condition is frequently seen as a complication of gonorrhœa. The other and more severe variety is attended with a large secretion of mucus, which clings tenaciously to the bottom of the vessel into which the urine has been passed. To this the term catarrh has been applied, a name which is justified by the amount of muco-purulent secretion thrown off by the vesical mucous membrane, and by the resemblance which it bears to the expectoration met with in certain cases of bronchitis.

The *treatment* of chronic cystitis necessarily resolves itself into a consideration of the causes producing the disease, which should be carefully gone over. Many of these—as, for instance, the presence in excess of certain of the inorganic constituents of the urine, stone, and stricture—are capable of correction; whilst others—such as tumors and the enlarged prostate—may only admit of a palliation of the symptoms to which they give rise. Still, the removal of the cause must be the first object in treatment, and is never to be lost sight of throughout.

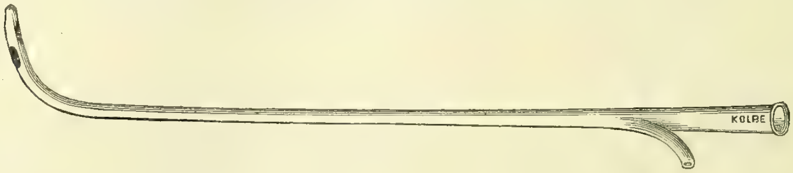
In the slighter forms of cystitis, removal of the cause, combined, perhaps, with the internal administration of buchu, or of an alkali with hyoscyamus, is sufficient to effect a cure. Further, the following indications will require fulfilling: (1) The complete emptying of the bladder; (2) its thorough cleansing and astringing; (3) the promoting of a healthy tone in the mucous membrane, by the use, for the most part, of internal medicines having some specific action.

(1) As residual urine by its decomposition is a frequent cause of vesical catarrh, provision must be made for the complete emptying of the viscus as often as may be necessary. This is best accomplished by the use of a catheter which the patient may be taught to pass for himself. Among catheters of various kinds, preference will generally be given to those made of soft rubber, which are admirably adapted for the purpose; they wear well, and are not apt to crack about the eye, as is often the case with the ordinary elastic, olive-pointed instruments, which are favorably known by reason of their easy introduction. The frequency with which the catheter is to be used varies in different cases. In some, it is sufficient to draw off the residual urine once or twice in the twenty-four hours; whilst in others, until the cystitis has to some extent subsided, the catheter may be required more frequently.

(2) The bladder must not only be kept thoroughly cleansed, but the use of astringent injections is, moreover, often highly beneficial. To commence with, tepid water in small quantities may be employed, by attaching a glass

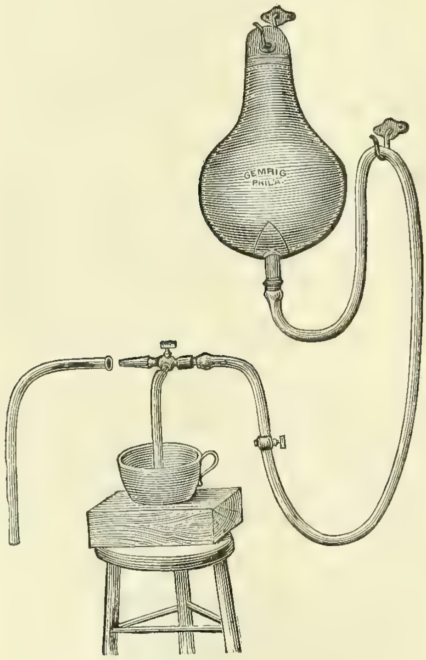
funnel, with about two feet of rubber tubing, to the end of a catheter. When the funnel is held up and water poured into it, the current passes into the bladder; by lowering the funnel, the water escapes. In this way the viscus can be thoroughly cleansed; or the same can be effected by means of a rubber bottle or syringe, fitted to the end of an ordinary catheter, or, which some surgeons prefer, a double-current catheter. Where it is necessary to continue the operation for a length of time, Keyes's apparatus will be found exceedingly useful. From the accompanying sketch (Fig. 1286) this is seen to consist of a vulcanized-rubber bottle, which is capable of holding a pint of fluid, and which, by means of a ring, can be suspended to any convenient hook; and a piece of tubing, five feet in length, terminating in a stopcock, which permits fluid to flow either through the catheter-end or the outlet-pipe, according to the direction in which the tap is turned. A conical, metallic, catheter mouth-piece completes the connection with the catheter. A soft-rubber catheter is generally preferred. The instrument is used in the following way: The bag, being filled with the fluid to be injected, is hung up about six feet from the floor; the stopcock is then turned until some of the fluid escapes, so that no air is allowed to enter the bladder. The patient being in the erect position, then introduces the catheter, and connects it with the tubing. By the alternate action of the tap, the fluid is made either to enter the bladder, or to escape; if the latter, it passes into the receptacle. The instrument can be readily adapted to the recumbent position. Beyond other advantages which the apparatus possesses, it enables patients to perform this operation without assistance. Care should be taken to prevent the forcing of air into the bladder along with the fluid injected. When the urine is bloody, the presence of air in the bladder speedily leads to putrefactive changes and to the evolution of gas in considerable quantities, which not only is offensive, but is capable of producing retention of a very painful character.

Fig. 1285.



Double-current catheter for washing out the bladder.

Fig. 1286.



Keyes's apparatus for irrigation of the bladder.

There is a source of annoyance that patients occasionally complain of, which it is easy to avoid. As the bladder is expelling the last portion of the injection, if the surgeon is holding the catheter he sometimes feels a slight click, or shock, which the patient with a sensitive bladder is conscious of, and which, though it is very momentary, he rather dreads on the next occasion that the operation has to be repeated. Guthrie refers to these sensations as "the fluttering blows of the bladder." He speaks of them as simulating stone and indicating the presence of sacculi. The click seems to be caused by the mucous membrane being sucked into the eye of the catheter as the bladder is emptied of the last few drops, for I have never noticed it when using a solid instrument, such as a bougie. It is to be avoided by carefully watching the flow, and, as it is terminating, by withdrawing the catheter till the end is well within the prostatic urethra. It is better to do this than to obviate the inconvenience by having a catheter with several small openings, as such an instrument is liable to break. A catheter for washing out the bladder should have the eyes of moderate size, with their edges bevelled like those of the American instrument, so as not to scratch the urethra; the openings should be as near to the end as possible to avoid the introduction of an unnecessary length of tubing.

To cleanse the bladder, injections of tepid water with about ten grains of borax to the ounce are generally employed: when the urine remains in an unhealthy condition for some time afterwards, one drop of nitric acid or five of the tincture of perchloride of iron in half a pint of warm water may be substituted with advantage.

When the urine is muco-purulent, after cystitis consequent on stricture or stone, injections of quinine are often beneficial. Attention was first called to the value of this drug in these cases by Mr. Nunn,[1] who speaks of its acting as a bactericide in the chronic form of cystitis known as catarrh; when the urine is purulent and offensive, it has been found exceedingly efficacious. The neutral sulphate of quinine, dissolved in distilled water, in the proportion of two grains to the ounce, will be most suitable. If the solution is not quite clear, a drop of dilute nitro-muriatic acid is to be added, and then it should be strained. A quantity not exceeding two ounces may be injected by a catheter and rubber bottle, the patient being instructed to retain the injection, if possible, for a time, provided that doing so be not distressing. The internal administration of quinine, in ten-grain doses, has not only been found to act as a sedative to the bladder, but is useful in arresting putrefactive changes in the urine. Its efficacy for this purpose has been urged by Dr. Simmons, who, in explaining the nature of this action, refers to an observation by Dr. Kerner, that seventy per cent. of the drug is eliminated by the kidneys in from three to twenty-four hours after it has been taken.[2]

To alleviate the extreme irritability of the bladder which often remains after the more active symptoms of inflammation have passed away, a solution of morphia, injected into the organ by means of a gum-elastic catheter to which a ball-syringe has been attached, often gives the patient a good night after rectal suppositories in various forms have been tried without success.

For a similar object, I sometimes employ in these cases vesical pessaries, containing either morphia or belladonna, or other soothing agents. These are passed into the bladder by means of a specially adapted catheter in which the pessary is placed. With this instrument the whole of the urine is first drawn off, after which, by pressing the stylet, the pessary is projected into the bladder. The pessaries are made with oleum theobromæ, and are so shaped as to fill in the open end of the catheter, thus giving it the appearance of an ordinary instrument. The shape of the pessaries is shown in the figure (Fig. 1287, A). A grain of morphia introduced into the bladder in this way, and repeated when necessary, often completely relieves the distressing symptoms of irritation. The use of these vesical pessaries has been extended to other cases where astringent applications to the bladder are indicated, and extended experience has shown the advantage, under certain circumstances, of this mode of medicating the bladder.

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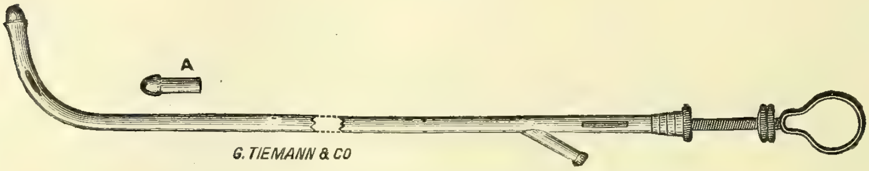
[1] Lancet, Feb. 23, 1878.

[2] American Journal of the Medical Sciences, April, 1879.

Fig. 1287.



Harrison's catheter for introducing pessaries into the bladder.

There is a variety of opinion with reference to the power of the bladder to absorb drugs introduced into it, as well as the constituents of the urine, in certain cases. That some special provision does exist to prevent the normal mucous membrane from absorbing readily, there can be no doubt. When, however, the lining membrane of the bladder becomes altered by diseased action going on in its interior, it then seems capable of absorbing not only drugs, but also certain products into which urine is resolved when it undergoes decomposition. In this way are explained cases of ammonæmia which have been recorded.

It often happens that though the inflammation has been removed and the bladder cleansed, this long remains preternaturally sensitive and irritable. Where other means have failed to give relief under these circumstances, the application of hot water to the interior of the organ has been found of much service.[1] Commencing at a temperature of 100° F., measured by the thermometer, increasing quantities of water are injected daily, and the temperature gradually raised, until, in some instances, 120° F. has been reached. Dr. R. F. Weir[2] refers to the value of the hot douche in cases of this nature, and Mr. Guthrie[3] also appears to have derived considerable advantage from its employment.

It will be proper here to draw attention to a mode of treating cystitis which has been recently advocated by Mr. John Chiene,[4] under the name of bladder-drainage. Its object is to keep the viscus unemployed as a reservoir, and so to give it complete rest for as long a period as may seem desirable. This is effected through siphon action by means of a catheter and piece of rubber tubing, which convey the urine, as it drops from the ureters, into a vessel beside the patient's bed. Some excellent results have in this way been obtained, not only in chronic cystitis, but also in other urinary affections in which it is necessary to keep the bladder empty and the patient dry. It is another illustration of what John Hilton wrote of as the value of physiological rest.

(3) The third indication is to promote, by internal remedies, a healthy tone of the vesical mucous membrane. Amongst these remedies are two specially worthy of mention, namely, uva ursi and buchu, which are often of great value in this stage of the complaint. A formula of Dr. Gross's will be found exceedingly useful. It consists of one ounce and a half of the leaves of the

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[1] Harrison, The Prevention of Stricture and of Prostatic Obstruction. London, 1881.
[2] American Clinical Lectures (Seguin), vol. ii. No. 8.
[3] On the Anatomy and Diseases of the Bladder.
[4] Edinburgh Medical Journal, December, 1880.

uva ursi, and half an ounce of hops, or one drachm of lupuline, infused for two hours in a quart of boiling water, in a covered vessel. To the strained liquor are added two drachms of bicarbonate of sodium, and two grains of morphia if there be much pain. Of this mixture, a wineglassful is to be taken five or six times a day. It is of importance that only the recently made infusion should be used, as much of the volatile essential principle of the drug is lost in the preparation of the concentrated essences which, on account of their convenience, are now so extensively used. Amongst demulcents, ordinary barley water, and a decoction of the ulmus fulva or slippery elm, and of the triticum repens or couch grass, extolled by Sir Henry Thompson, will be found of service in allaying irritation.

In the treatment of cystitis, reference is often made to the reaction of the urine, as indicating the necessity for administering either acids or alkalies. Our object should be to obtain that condition of the excretion which is the least likely to provoke irritation. We sometimes find that alkalies are being poured in with a vigorous hand, quite regardless of the fact that healthy urine has an acid reaction. When, however, the acid is much in excess, or the mucous membrane inflamed, relief generally follows the administration of an alkali.

In some of these cases, when other means have failed, it is remarkable with what rapidity pus disappears from the urine under the influence of chlorate of potassium. It is best prescribed in the proportion of half an ounce of the salt to a pint of flavored water, a tablespoonful to be taken every three or four hours.

In reference to the precise manner in which chlorate of potassium acts in cystitis, it is conjectured, from an analysis by Ludwig, that the salt may be decomposed in the kidneys by the acid urine, and that chloric acid, being consequently set free, brings about a change in the reaction of the urine in the bladder.[1]

In regard to diet, Dr. George Johnson[2] has shown the value of milk, in both acute and chronic cystitis, its effect being to render the urine less irritating.

In the treatment of cystitis as it occurs in the female, there are no better instructions than those contained in a practical paper on this subject by Dr. J. Braxton Hicks.[3] The author points out how little is to be expected from internal remedies, beyond correcting the functions generally, and how much may be done by local treatment. Reliance is placed chiefly in washing out the bladder with slightly acidulated warm water, until it is clear of phosphates and mucus, and afterwards injecting, with a view to its retention, a solution of morphia. Subsequently the permanganate or chlorate of potassium is employed in a similar manner. On the subsidence of the acute symptoms, injections of tannin or of perchloride of iron, followed by morphia, are substituted, and are again changed as the bladder becomes less sensitive for more potent astringents, such as the nitrate of silver.

Lastly, it must not be forgotten that there are cases of chronic cystitis which appear to be quite irremediable by any methods such as those referred to. In these the bladder is little else than a chronic abscess-cavity, into which urine finds access. Under these circumstances, cystotomy, in the male, becomes a justifiable proceeding; whilst, in the female, the establishment of a condition of temporary incontinence by dilatation of the urethra, is frequently followed by permanent relief. The advantages of cystotomy as a means of permanently relieving this condition in the male, have been urged by Dr. R. F. Weir,[1] who in a brief history of the operation furnishes a table of forty-seven cases, with the following results: By median perineal section, there were ten cases, six patients being cured, three relieved, and one dying. By the lateral section there were thirty-two cases, thirteen patients being cured, four relieved, and eleven dying, while in four cases the operation failed. By the bilateral section there were five cases, four ending in cure, and one in death. In the selection of the precise mode of proceeding, the median incision will be found to have an advantage by reason of its greater immunity from hemorrhage. Care, however, must be taken, when it is adopted, to secure urinary incontinence for some days at least, either by inserting through the wound a lithotomy tube by which urine can constantly escape, or by over-distending the prostatic urethra with the finger, or with a dilator. Where the lateral incision is practised, incontinence naturally follows, as after the removal of a stone from the bladder in this way. Dr. Hayes Agnew[2] has suggested that, in hopeless cases of chronic cystitis, the patient might be made comfortable by separating the connection of the ureters with the bladder, and bringing them out through the abdominal walls, establishing fistulæ either in the iliac or in the lumbar region, and thereby diverting the urine entirely from the bladder. Dr. Agnew supports this very formidable suggestion by a reference to the experience of persons suffering from certain urinary fistulæ occasioned by accident. Though the feasibility of such a proceeding has been tested on the dead subject, it has not hitherto been illustrated clinically.

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[1] Lancet, Feb. 25, 1882.

[2] Ibid., Dec. 16, 1876.

[3] British Med. Jour., July 11, 1874.

Ulceration of the Bladder.

This is an occasional result of inflammation. I have known it occur as a consequence of the retention in the bladder for some days of a catheter ill adapted for the purpose. Most frequently it happens in bladders which have become inflamed whilst in a paralytic condition, when it is probably associated with some changes in the spinal cord. Where catheterization is employed under these circumstances, extreme care is necessary in consequence of the insensitive condition of the patient, not to occasion any damage to the mucous membrane of the bladder which may be followed by ulceration. Hilton[3] refers to a case of this kind, in which, after death, three ulcerated patches were found at points corresponding with those which the catheter touched daily. The same author also relates a case in which a patient was in the habit of daily catheterizing himself. One day, on being sent for, Mr. Hilton found him dying of peritonitis brought on by perforation of the bladder. After death a perforated ulcer was found corresponding with the very spot upon which the end of the catheter must have pressed. Similar care is required to avoid anything like continuous pressure on the vesical wall when a catheter has to be retained. The possibility of ulceration of the bladder, when associated with stricture of the urethra, being followed by rupture and extravasation of urine into the surrounding tissues, should not be lost sight of. Though such an occurrence is extremely rare, there are instances in which it is most likely that this took place. This was probably the nature of the case recorded by Dr. T. K. Cruse.[4]

Exfoliation of the mucous membrane of the bladder has occurred in association with ulceration. Cases[5] are recorded in which the entire lining has been thrown off and has caused retention, or, in the female, has been extruded through the urethra. In some instances of this nature the mucous membrane appears to have been dissected off by ulceration from its subjacent coat; whilst in others this effect has been the result, not of molecular death, but of the conversion of the entire membrane into a slough, by reason of the violence of the preceding inflammation.

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[1] On Cystotomy for Cystitis in the Male, New York Med. Journ., June 12, 1880.
[2] Philadelphia Medical Times, Feb. 12, 1881.
[3] Guy's Hospital Reports, 3d series, vol. xi.
[4] Rupture of the Bladder dependent on Stricture of the Urethra. Medical Record, Aug. 1, 1871.
[5] Trans. Path. Soc. Lond., vol. xv.

Perforating Ulcers.—Some remarkable instances of perforating ulcer of the bladder have been recorded, where, apparently, there were no indications of the presence of the affection previous to the setting in of fatal symptoms. To this category belongs the interesting case recorded by Mr. Bartleet, of Birmingham,[1] where the ulceration made its way into the ileum, and caused death, as it were accidentally, by setting up peritonitis. The ulcer, whilst confined to the bladder, as Mr. Bartleet remarks, appears to have gone through all its stages without presenting any symptoms, the patient continuing to follow his accustomed occupation. A sudden lifting movement, which occasioned acute pain, probably broke down a recent adhesion between the bladder and the bowel, leading to extravasation of urine into the peritoneal cavity, and thus ultimately causing death. The possibility of rupture of the bladder from muscular contraction being preceded by ulceration, the symptoms of which have been in abeyance, must not be forgotten. Dr. Padley[2] has recorded a case in which extravasation of urine into the abdominal areolar tissue, followed by cellulitis and sloughing, was probably preceded by ulceration of the bladder. This patient had previously been under treatment for a perforating ulcer of the soft palate. Communications between the bladder and intestines appear, in some cases, to have existed for considerable periods of time, and to have led to formation of stone within the former. In the early days of lithotrity, Mr. Charles Hawkins[3] recorded a successful case of this kind. As the intestines are more prone to ulceration than the bladder, it is probable that, as a rule, the latter becomes only secondarily involved.

Symptoms.—The symptoms of ulcerated bladder do not differ essentially from those of cystitis. The urine is frequently tinged with blood, and contains fragments of disorganized mucous membrane. Such patients are often sounded, on the suspicion that a stone may be present, with the result of considerably aggravating all their symptoms.

Treatment.—The simpler forms of ulceration hardly require any special treatment. Where there is reason to believe that this condition exists, every care should be taken to prevent over-distension, and to avoid the unnecessary introduction of instruments into the bladder.

HYPERTROPHY AND ATROPHY OF THE BLADDER.

HYPERTROPHY OF THE BLADDER may be regarded as a natural consequence of obstructed micturition. As in the circulatory system, the heart, by an increase of its bulk, adapts itself to meet any obstacle which may be placed in front of it, so in the urinary apparatus does the bladder, by proportionate development, make provision for any additional resistance which it has to overcome.

With reference to uniform hypertrophy of the bladder, there is comparatively little to be said. There are, however, extreme variations in the relations existing between the amount of hypertrophy and the capacity of the viscus, a circumstance which has caused some authors to speak of concentric and excentric hypertrophy, as indicating that in the one the increased development of the muscular coat is at the expense of the cavity, whilst in the other the condition is reversed. Both conditions, in variable degrees, are commonly met with, and are explicable by individual differences of vesical irritability. One person with a stricture will make water on every available occasion, whilst another, similarly situated, rather shirks the straining which the act requires, and consequently is disposed to err in an opposite direction. This is a reasonable explanation of the varying degrees of bladder-capacity observed in otherwise similar cases of uniform hypertrophy. As a rule, hypertrophy exists as long as there is a cause for it. When the stricture, or other obstacle, is removed, the hypertrophy, in most cases, gradually disappears. This condition is sometimes, however, a cause for the continuance of irritability and frequent urination, long after the stricture has been, to all intents and purposes, sufficiently relieved. Under these circumstances, cystotomy has been resorted to with good results. It may be asked, What is the rationale of this? How is an hypertrophied bladder, with a small capacity, to be made capacious and tolerant by not allowing urine to collect in it for an interval of two or three weeks or more? The explanation is to be found in the fact, that, for the time being, the bladder is prevented from acting as a muscular organ, and that atrophy, or loss of muscularity, therefore, follows. Possibly it is only under circumstances such as these, that anything need be said with regard to the treatment of uniform vesical hypertrophy. When, however, the hypertrophy is partial—when the increase is confined to one set of fibres, or to one part of the bladder—symptoms are produced, and changes are brought about, which will require further remark.

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[1] Lancet, February 5, 1876.

[2] Lancet, March 4, 1882.

[3] Medico-Chirurgical Transactions, vol. xli.

There is a condition which has been described as a columniform state of the bladder, in which the interior presents an appearance similar to that of the cavities of the heart, the muscular fibres not being spread out uniformly, but being collected in bundles, like the *columnæ carneæ*. Hence the name. Between these elevations are corresponding depressions, against which the urine is forced when the expulsive power of the bladder is exercised. In this way sacculi are formed, as will be presently noticed. This is a condition frequently observed in connection with prostatic hypertrophy. It is usually associated with dilatation of the bladder, and with fatty degeneration of its muscular coat. There is a tolerably frequent example of limited hypertrophy which was pointed out by Mr. Guthrie,[1] where, in connection with enlargement of the prostate, a bar is formed at the neck of the bladder by the excessive development of the muscular fibres in that locality. As an illustration of limited hypertrophy it is referred to here, but it will require fuller consideration in a separate section. Amongst hypertrophies limited to certain portions of the bladder, must be included those in which an excessive development of muscular fibres has taken place between the orifices of the ureters. In this way, in a case recorded by Mr. Bickersteth,[2] a bladder was practically divided into two compartments by a muscular barrier thrown across between those openings, and considerable difficulty was experienced in the removal of a stone with the forceps, after the bladder had been opened, the stone being lodged in the upper depression.

Atrophy of the Bladder.—In this condition, which is only rarely met with, the bladder, either by accident or otherwise, is rendered incapable of acting as a reservoir by reason of the urine escaping immediately after entering it. In some reported cases of malformation and of extensive vesical fistula, this change appears to have taken place, the bladder being little else than a rudimentary organ.

[1] Op. cit., p. 271.

[2] Liverpool Med. and Surg. Reports, vol. i. 1867.

Sacculated Bladder.

The formation of sacculi, or pouches, in connection with the bladder, is observed in cases of enlargement of the prostate and other disorders in which freedom of micturition is interfered with. It most frequently exists, as already stated, where hypertrophy of the muscular coat has taken place, the explanation being that the mucous membrane protrudes between the meshes of muscular fibres. In these depressions urine lodges. Under the pressure exercised by the bladder during micturition, these pouches deepen, until, perhaps, they are capable of containing several ounces of urine. They may form at any part of the bladder where the mucous lining is unsupported by muscular fibre. The presence of these sacs often occasions serious inconvenience; they are spaces in which urine collects and decomposes; not unfrequently calculi have been found in them; and in some recorded instances, by concealing sharp fragments of stone after lithotrity, they have contributed to the production of a fatal cystitis. Hence they are considerable sources of embarrassment to the surgeon in his treatment of many vesical affections—an embarrassment which is by no means lessened by the fact that their existence is difficult to determine. The following case, recorded by Dr. Warren,[1] illustrates some of the features of sacculated bladder:—

The patient, fifty-two years of age, had had symptoms of vesical disease for twelve years. The urine was alkaline, contained pus, and was passed frequently and with pain. An examination with a sound detected a stone. Some vesical pain followed the passage of the instrument, and the urine became strongly ammoniacal; an attempt was therefore made to wash out the bladder with warm water injections, but the expulsive efforts were so great as to force out not only the water as fast as injected, but also the soft-rubber catheter employed. Finally, a small quantity was introduced at a time, but, however often this was repeated, the injected water came away dark, and foul in odor. All the symptoms grew worse; the urine was passed in a putrid state; and the patient died on the ninth day after the examination.

At the autopsy, the bladder was found to consist of four compartments, three of which contained calculi. In the central one was a large phosphatic stone, nearly spherical, and five centimetres in diameter. The other stones were about two centimetres in their longest diameters, and were somewhat flattened. They were dense, and probably consisted of urates. The walls of the bladder were much thickened, and there was a diphtheritic inflammation of its mucous membrane. The kidneys were large, soft, and contained small abscesses; the ureters were dilated.

When the existence of sacculi is suspected, it is not a bad plan, after catheterizing the patient while recumbent, and thus emptying his bladder, to alter his position by making him stand, and then to see if more urine escapes on moving the catheter gently about; or the order in position may be reversed. Guthrie[2] mentions the case of a gentleman in whom the existence of one or more pouches was determined by injecting the bladder with warm water; on withdrawing it only a portion would be obtained, and rarely the whole of it, even by any change of position.

I saw a gentleman who had irritability of the bladder, and who was suspected to be suffering from stone. I had searched his bladder with a sound, and also with a catheter, for a cause, but in vain. One day, on examining him with a prostatic catheter, after having apparently emptied the bladder, in moving the instrument about I felt it suddenly pass over something with a jerk, and then, on gently pressing it, it went a couple of inches further in. This was followed by the discharge of about two ounces of milky-looking urine. There was no bleeding. My patient went home, pondering over the suggestion made to him—that his vesical irritability was due to a sacculation in which urine lodged, and which we had accidentally discovered. He was immediately relieved, and remained so for forty-eight hours, when the feeling of irritability returned. Having had some experience in catheterizing himself, he again passed the same instrument, and, having drawn off some water, he began cautiously to feel about his bladder, with the same result as before. The patient came to the same conclusion that I had, namely, that he had a sacculated bladder, and, being an ingenious man, he devised a stylet by which he could readily pass his catheter into the secondary receptable. When I saw him last, he informed me that, by in this way passing an instrument for himself, from time to time, he had been completely cured of his irritable bladder; and he believed that the sacculation had almost, if not entirely, disappeared.

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[1] Boston Medical and Surgical Journal, March 21, 1878.

[2] Op. cit., p. 30.

As bearing upon the difficulty of recognizing sacculi, I will quote the following remarks from an eminent authority:—

> It will naturally be asked, How can this state of sacculation of the bladder, with or without stone, be diagnosed during life? It must, I fear, be admitted that the indications are few and unreliable. By noting that a man, having an enlarged prostate, makes water slowly and with considerable exertion; that when a catheter is used, and after the bladder has been apparently emptied, there is a still further flow; and particularly if the appearance of the urine during the double flow vary considerably, we may infer that cysts or sacculi do exist, although we cannot surely know it.[1]

Careful examination of the region of the bladder may sometimes tend to the detection of sacculation. Examination of the supra-pubic region with the hand should also not be omitted. I was reminded of the importance of this on looking through the specimens in the Museum of the New York Hospital. Appended to one (784), where there was a sac larger than a hen's egg, opening into the bladder near the fundus, and in which there were several calculi, was the note, "These calculi could not be detected by the sound during life, but the pouch containing them could be felt through the abdominal parietes."

As an illustration of the enormous dimensions to which a sacculus may attain, reference may be made to the case reported by Dr. Murchison,[2] in which a large abdominal tumor was thus produced. The nature of the tumor was determined by puncture. In another case, recorded by Dr. Warren,[3] such a sacculus had assumed many of the characteristics of a considerable ascites. Amongst the consequences which may arise from sacculation of the bladder involving its posterior wall, suppuration of the sacculus must not be overlooked. This probably results from its containing decomposed urine, which, owing to some sudden change in position of the parts, cannot find exit into the general cavity of the viscus, and consequently sets up suppuration. An abscess has been thus formed which opened into the rectum, and in this way a communication between the bladder and rectum has been established. It is probable that this was the course of events in a case of recto-vesical fistula with fecal calculus, in a man, reported by Dr. W. R. Williams.[4] Pelvic cellulitis has also been similarly provoked.

Treatment.—Beyond the removal of any cause, such as a stone or other impediment to micturition, which may have favored the production of sacculation, there is but little that can be done in the way of treatment for this affection. Care must be taken that the bladder is kept regularly emptied, as far as it is possible to do so, and its cavity must be cleansed by injection if necessary.

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[1] W. Cadge, Sacculation and Stone in the Bladder. Brit. Med. Journal, October 2, 1875.

[2] Trans. Path. Soc. Lond., vol. xiv.

[3] American Medical Times, N. S. vol. iv.

[4] Lancet, Oct. 1, 1881.

TUMORS OF THE BLADDER.

In undertaking to treat of the various tumors affecting any organ of the body, the first difficulty which arises is the selection of a classification which will alike meet clinical and histological requirements. To effect anything like harmony is, in the present state of pathology, well nigh impossible. A strictly histological arrangement would not be found to suffice for clinical study. Hence, in view of the principal object of this article, the subject will be approached with reference to clinical rather than other purposes.

Tumors of the bladder may be classified as follows: (1) Villous growths, or papillomata. (2) Mucous growths, or myxomata. (3) Fibrous growths, or fibromata. (4) Malignant or cancerous tumors.

VILLOUS GROWTHS, OR PAPILLOMATA, form the commonest variety of new growth met with in the bladder, and are most frequent after puberty. Tumors of this kind used to be described under the name of villous cancer, but there are no substantial reasons for regarding them as cancerous, or as even malignant: they show no tendency to ulcerate or to become open sores, to involve structures other than the mucous membrane, to implicate glands, or to become generalized. When they prove fatal, it is by hemorrhage and consequent exhaustion, such as might take place from a nævus. There are good reasons for believing that they may exist for long periods of time without giving any indication of their presence. Cases have been recorded in which there were considerable intervals between attacks of hemorrhage probably due to growths of this kind, and in which, during periods of quiescence, the patients remained comparatively free from inconvenience. In the museum of St. George's Hospital there is a specimen of such a growth, attached to the neck of the bladder of a gentleman aged eighty-one. His first attack of hemorrhage had occurred twenty years before death, and had lasted for eight months; following this had been an interval of four years; and then a recurrence of hemorrhage, which ultimately proved fatal. Brodie also refers to the disease as occasionally extending over a period of seven or eight years. This is altogether unlike the ordinary history of cancerous maladies.

Symptoms.—Until they occasion hemorrhage, more or less persistent or recurrent, there are usually no symptoms from which the existence of these growths may be suspected. The hemorrhage to which they almost necessarily give rise, leads to an exploration of the bladder, in the course of which a portion of the growth becomes detached; examination of clots and *débris* discharged under these circumstances has frequently led to the detection of the growth, by the evidence which the microscope has thus afforded. In a case of this kind in which I employed a double-current catheter for douching the bladder with hot water, a considerable piece of the growth was found blocking the return-tube. Mr. Davies Colley[1] has suggested that in cases of suspected villous growth, a wash-bottle and catheter, as adapted for the removal of fragments of calculus from the bladder, might be advantageously utilized to bring away portions of the tumor for verification of the diagnosis. A smooth-bladed lithotrite has also been used for the same purpose. Persistent and recurrent hemorrhage, unexplained by other causes, and the detection of portions of the growth in the urine, are the points in diagnosis upon which stress is laid. On examining these growths, it may sometimes be observed that the delicate fringes which mainly compose them are encrusted with phosphates sufficient to produce a gritty sensation when a metal sound is moved over them. As instrumental examination of the bladder, when a villous growth is present, is invariably followed by a large increase in the quantity of blood discharged with the urine, all unnecessary interference must be avoided.

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[1] Trans. Clin. Soc. Lond., 1880.

These tumors are occasionally multiple, a favorite site being near the openings of the ureters, around both of which clusters of the growth may be seen hanging. They are usually attached to an otherwise apparently healthy-looking mucous membrane, by a pedicle. There is no thickening of the walls of the bladder, and its lining membrane is the only part connected with the growth. In size they vary much, and some of the smallest have proved equally as fatal as the larger ones, from the continuous hemorrhage to which they have given rise. Occasionally they have caused retention of urine by occluding the internal opening of the urethra.

Microscopically, these growths consist of a number of villi, each of which is composed of a basement membrane continuous with that of the mucous or submucous connective, covered with a thick layer of columnar or spheroidal epithelium. Each villus incloses one or more capillary vessels, arranged in loops which often present a varicose appearance.

Treatment.—With regard to the treatment of these growths, it must be remembered that there is nothing either in their structure or in their clinical history to lead to the belief that they would be incurable, provided that we had means of directly dealing with them either by destroying or removing them. On the contrary, there are reasons for believing that in a few instances they have disappeared, or at all events have ceased to produce symptoms; possibly, as Dr. Habershon has suggested, they may have been effectually disposed of by a process of sloughing, such as sometimes occurs with other vascular bodies. In considering their treatment, reference must be had, first, to the possibility of cure, and secondly, to the palliation of the symptoms to which they give rise. In dealing with some of the methods of treatment which have been successfully adopted, we are met by the objection that indisputable evidence of the presence of these growths has not in these cases been furnished; that is, though suspected, it has never been absolutely demonstrated; and this objection applies to a case of my own, hitherto unpublished, in which I had good reasons for believing that I was dealing with a papilloma:—

Early in 1877, a gentleman aged 34 consulted me for persistent hæmaturia: he begged that I would not sound him as others had done, assuring me that the absence of stone was proved beyond a doubt, and that each operation was invariably followed by a serious aggravation of his symptoms. He was very much blanched, and I was not sorry to acquiesce in his wish. He had been ill in this way for nearly three years, having from time to time varying periods during which the urine was free from blood. There was no cause that I could discover; no history of renal colic, nor anything to furnish a clue. A jolt in a carriage was invariably followed by a recurrence of the hemorrhage. He told me that he had taken almost every styptic and astringent that the pharmacopœia contained. I examined his urine, which contained blood and clots in considerable quantities, but could discover no organized shreds, though I looked for them on several occasions. At this time I was engaged in making some experiments on the arresting of hemorrhage with hot water. As I had come to the conclusion that the hemorrhage in this case was from the bladder, probably from a villous growth, I determined to try it here. Accordingly, a double-current catheter was arranged, with which the patient injected into his bladder, twice a day, small quantities of hot water in gradually increasing amounts. We commenced with water at 96° Fahr. and gradually increased the temperature until 116° Fahr. was reached, which point was maintained for nearly a month. In a week the blood had entirely disappeared. I saw this patient several years afterwards; he was perfectly well, and had suffered no recurrence of hæmaturia from the time that he had first used the hot douche.

I give this case for what it is worth, merely remarking that I believed it to be one of papilloma. The remarkable effect of hot water in blanching tissues and removing congestion from mucous membranes is now so well recognized, that I may be excused for referring to it in connection with its application to the treatment of these growths.

The use of astringents and styptics, by the mouth, or locally by injection, has not given any very reliable results. Gallic and sulphuric acids, acetate of lead, iron, turpentine, ergot, matico, and hamamelis, have all been tried with some degree of success. Of the various means for arresting hemorrhage and soothing the local irritation which is aroused, I have found the application of a bag of ice above the pubes, and the use of opium suppositories, of most service. The influence of cold and rest in controlling hemorrhage is well understood, and they are applicable here. My experience of heat, as already detailed, would lead me to try it again, provided that I could bring it in actual contact with the spot from which the hemorrhage proceeded. The injection into the bladder of a weak solution of nitrate of silver (gr. ½–f℥j), has sometimes proved efficacious.

The operative measures which have been resorted to will now be considered. As already pointed out, these growths are not necessarily of a malignant nature, and there is good reason for believing that occasionally they disappear spontaneously, either as a consequence of their accidental self-strangulation, or by sloughing, coincident with an attack of cystitis. Hence, with more perfect means for making a diagnosis, there is no reason why they should not be included with others which are curable by operation. Civiale appears to have attempted their removal by evulsion with the lithotrite, but the results of this somewhat hazardous and indiscriminate mode of procedure do not seem to have encouraged its adoption by other operators. The precision and freedom necessary for the complete removal of these tumors can obviously only be obtained by cystotomy and direct exploration of the bladder. To remove a portion of a villous growth is worse than useless.

The first complete operation of this kind appears to have been performed by Mr. Crosse, of Norwich, who, like other operators, performed cystotomy under the belief that the bladder might contain a calculus. A mass of polypoid excrescences was found and removed, but the child died in forty-eight hours.

From this date (1835) up to the present a somewhat similar procedure has been adopted in at least ninety-eight cases, as will be seen from the table on page 360. Dr. Gross points out that, on account of the multiplicity of the tumors, the operation holds out little prospect of relief in children unless it be by supra-pubic incision. In a case recorded by Mr. Howard Marsh,[1] both the bladder and vagina of a child of two years were completely filled with polypoid excrescences. We may now proceed to consider in detail the various operations which have been adopted in these cases.

The bladder has been opened in the following ways: (1) by median cystotomy, (2) by perineal urethrotomy and dilation of the vesical neck, (3) by lateral cystotomy, (4) by median cystotomy, followed by supra-pubic incision, (5) by supra-pubic cystotomy alone, (6)—in the female—by rapid dilatation of the urethra, and (7) by section of the urethra and extension of the incision into the base of the bladder.

Lateral cystotomy, as for stone, was the operation practised in Professor Humphry's case. There is much to be said in favor of the lateral over any median operation. By means of the former, a far more thorough exploration of the bladder can be made with the finger, and, if necessary, additional room can be readily obtained by bilateral section of the prostate, as is done for the removal of large stones. Possibly a *median cystotomy* may commend itself to some by reason of the diminished risk of wounding any vessel large enough to give rise to troublesome, if not dangerous, hemorrhage. It must be remembered, however, that complete ablation of the growth is the object of the proceeding, and that on the thoroughness with which this is done depends its success. From a tolerably large experience of lithotomy and cystotomy, I have no hesitation in saying which mode of opening the bladder gives the greater facilities for conducting manipulations within its interior. If a lateral cystotomy were found not to provide sufficient room to permit of the removal of the growth, *supra-pubic incision* might supplement it after the plan adopted by Billroth.[1] In his case, the tumor having been removed, a drainage-tube was passed through the bladder and allowed to hang out from the lower opening.[2] In the female, *dilatation of the urethra* is the first proceeding to be adopted, and in some instances this alone has given ample room. Where more space has been required, a *median incision through the urethra and vesico-vaginal septum* has been practised.

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[1] Trans. Path. Soc. Lond., vol. xxv.

Having obtained access to the tumor or tumors, we may now proceed to consider the various means by which they may be separated from the vesical walls. In some cases, avulsion with the finger, aided, as in Humphry's case, by the forceps, has been sufficient. In Crosse's case scissors were employed. In the female, ligature of the growth has been more frequently resorted to than any other proceeding. A convenient mode of applying the ligature is by a double canula; in this way the loop can be slipped down to the attachment of the tumor and strangulation readily effected. From none of the reports of the operation does it appear that any serious or uncontrollable hemorrhage has resulted.

Dr. Gross suggests that before resorting to any cutting operation irrigation of the bladder might be tried. I have already alluded to a case in which a considerable portion of a villous growth was found impacted in the return-tube of a double-current catheter.

MUCOUS GROWTHS OR MYXOMATA, identical in every respect with the mucous polypi of the nose, are occasionally met with in the bladder. The extent of their surface-connection with the vesical lining membrane is variable, the attachments of the growths being slight and fragile in some cases, while in others they involve a considerable area. They are entirely confined to the mucous membrane, being unconnected with the other coats of the organ. Not unfrequently they are associated with more or less hypertrophy of the muscular tunic, a circumstance which is readily explicable.

The *symptoms* to which these growths give rise simulate those of stone in the bladder. It has, however, been generally noticed that in striking contrast to what happens with villous growths, myxomata are seldom accompanied by hemorrhage. The bladder is irritable, and there is much pain and straining; the urine usually contains mucus and an abundance of epithelium. Examination of the bladder by the sound, in conjunction with the finger in the rectum, determines the absence of a stone, and the probable presence of a growth, which, in some instances, has been so large as almost to fill the interior of the viscus. In the female, dilatation of the urethra and direct exploration of the bladder with the finger can, generally, be practised.

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[1] Archiv f. klin. Chir., Bd. xviii. S. 411.

[2] Dr. A. Patterson (Glasgow Medical Journal, April, 1882) has recently recorded a case of lithotomy, in which, after making the lateral incision into the bladder, it was found impossible to extract the stone by this way. A supra-pubic opening was made in addition, and through this a large calculus was withdrawn. The patient made a good recovery.

Amongst the most characteristic instances of these growths are those recorded by Mr. Crosse and by Mr. Savory.[1] In the former, the bladder, on being opened, was found filled with polypi, in every way resembling those of the nose. Their removal could only be effected by the finger and a pair of scissors, and death occurred after violent fits of tenesmus within forty-eight hours. In Mr. Savory's case, the patient, a female child aged thirteen months, had suffered from symptoms resembling those of stone. This case was further complicated by the existence of a patent and suppurating urachus, a condition probably attributable to the passage of urine by the urethra having been obstructed by the tumor within the bladder. Post-mortem examination showed this to consist of a pendulous growth, identical in structure with nasal polypi, attached to the inner surface of the bladder behind the orifices of the ureters, which were much dilated. The specimen will be found in the Museum of St. Bartholomew's Hospital. It has been said that a growth of this kind may be mistaken for eversion of the bladder, or for a vascular tumor of the urethra. Careful examination with the finger or the probe, for the purpose of tracing the relations and connections of the protrusion, will insure a correct diagnosis.

FIBROUS GROWTHS OR FIBROMATA are, as the name implies, firmer and more fibrous in their structure than the tumors already considered. These growths appear to take origin in the submucous tissue of the bladder, being circumscribed in their attachment, or even pedunculated. One of the best examples of this kind of growth, to which reference has been made in connection with cystotomy for intra-vesical tumors, is recorded by Professor Humphry.[2] It is as follows:—

W. N——, aged 21, light-complexioned, healthy-looking, was admitted into Addenbrooke's Hospital, Cambridge, on September 17, 1877. Six weeks previously he had begun to feel pain at the root of the penis after micturition, and the desire to pass water had become frequent. At the time of his admission he had, in addition, blood in the urine after any exertion; but this subsided completely, or nearly so, when he remained in bed. He several times made the attempt to get up; on his doing so, however, the blood invariably reappeared, and the other symptoms were aggravated. Occasionally the flow of water suddenly stopped during micturition. There were pus and blood-corpuscles in the urine, also crystals of oxalate of lime and epithelial scales, but no casts from the kidneys.

I sounded him on two or three occasions, but could not discover a calculus, nor obtain any other information as to the nature of the disease. The sounding was always followed by bleeding. Under treatment, the oxalate crystals disappeared, but no improvement in the other symptoms took place. On the contrary, they became more severe, especially the pain and straining, which were relieved only by opium. A flexible catheter was left in the bladder, but it could not be borne. A firmish mass could be felt above and behind the pubis, and from the rectum; it appeared to occupy the position of, and to be connected with, the bladder. The patient wasted, and his sufferings were so great that I determined to make an incision into the bladder, for the purpose of ascertaining the precise nature and situation of the disease, and of taking any further steps which might offer a prospect of relief. If the disease were merely inflammatory and ulcerative, a free exit for the contents of the bladder might prove beneficial. If, as there was much reason to believe, a growth had taken place into the bladder, the operation would do no harm, and there might be a possibility of removing the growth.

Accordingly, on October 17, I cut into the bladder on a staff introduced through the urethra, making the usual incision for the lateral operation of lithotomy, and, introducing my finger, found the bladder occupied by a firm mass, about the size of an orange, with a ragged surface. It was attached by a pedicle as thick as my finger, to the interior of the bladder, near the orifice of the right ureter. Partly with the finger, and partly with forceps, I contrived to tear through this pedicle, and then extracted the detached mass with lithotomy forceps. I next, with my finger-nail, scratched out what I judged to be the root of the polypus, taking care not to perforate the coats of the bladder, for fear of admitting the urine into the cellular tissue of the pelvis. The growth was of moderately firm structure, of the kind called fibroma or fibro-sarcoma.

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[1] Med. Times and Gazette, vol. ii. 1852.

[2] Medico-Chirurgical Transactions, vol. lxii.

During four and twenty hours after the operation, great pain was experienced about the region of the bladder; the urine flowed through the wound. For two days subsequently there was comparative ease. Then the pain returned with even greater severity than before the operation. It was relieved only by subcutaneous injections of morphia, the quantity of which we were obliged to increase till it amounted to three grains in the twenty-four hours. In the intervals, when the influence of the morphia was passing off, the patient's cries were loud and incessant. The wound became coated with phosphates, and the bowels were very constipated, evacuations being obtained with much difficulty through the agency of medicines and enemata. This state of things went on for about two months. We supposed that the disease had returned or had been incompletely removed, and we had little hope of the patient's recovery. After that time, however, to our surprise, he began to mend; the pain diminished, and the quantity of morphia was lessened; the wound assumed a healthy appearance and healed up; the urine was passed by the natural passage, without pain and at longer intervals. In the early part of January, 1878, he was well enough to return home, and was quite well and at work in January, 1879.

With reference to *the treatment* of the last two forms of vesical tumor which have been described, the remarks made in connection with the subject of papilloma are equally applicable. The removal of these growths has been safely effected by cystotomy, which is, as a rule, to be recommended.

Before proceeding to consider the remaining group of tumors affecting the bladder, I would take the opportunity of urging the more general employment of cystotomy as an exploratory operation in cases of doubtful nature, where there are good reasons for believing that the disease is situated within the limits of the bladder, and where other treatment has failed to give relief. Where tumors have in this way been discovered, and have been found to be beyond removal, the patient's condition has not, as a rule, been seriously aggravated by a properly performed cystotomy. On the contrary, there are many instances where, though the operation may have failed to cure, it has relieved by freeing the patient from the distress which is invariably associated with impeded micturition and pent-up discharges, derived both from the urine and from the growths.

[Dr. Stein,[1] of New York, has collected 98 cases in which tumors have been removed from the bladder, 53 in male and 45 in female patients. The nature of the operation, and the result, in these cases, may be seen from the following table:—

Nature of operation.	Cases.	Recovered.	Died.	Undetermined.	Mortality per cent.
(*Males*).					
External perineal urethrotomy . . .	31	17	14	...	43.9
Perineal cystotomy	10	6	3	1	33.3
Supra-pubic cystotomy	10	...	8	2	88.9
Perineal and supra-pubic incisions combined .	2	1	1	...	50.0
(*Females*).					
Urethral dilatation	37	24	10	3	29.4
Vaginal incision	8	5	3	...	37.5
Aggregates	98	53	39	6	39.8

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[1] Medical Record, March 14, 1885.

It should be mentioned also that Civiale succeeded in removing a small tumor from the male bladder by grasping it with a lithotrite, and that Sonnenburg has removed a fibro-sarcoma from the female bladder by resecting its anterior wall. The patient died some weeks after the operation. Liston removed a cyst of false membrane, or, more probably, a cast of exfoliated mucous membrane, from the bladder by the supra-pubic incision, and successful perineal operations, not included in Dr. Stein's list, have been recorded by Duplay, Pitts, and Anderson.]

MALIGNANT GROWTHS OF THE BLADDER.—Among malignant and cancerous tumors affecting the bladder, we must include some which involve it by contiguity. The kinds of *carcinoma* affecting the bladder are, scirrhous, encephaloid, and epithelial. Authors appear to differ considerably in their estimates of the relative frequency of these. Scirrhus, as far as my own observation goes, when it affects the bladder does so only secondarily, that is to say, as an extension from some other organ, such as the uterus or vagina in the female, or the rectum or prostate in the male. Gross[1] observes that—

> The usual variety of carcinoma, met with in the bladder, as shown by modern histological research, is the epithelial. What was formerly known as scirrhus, is nothing more than the firm, infiltrating form of epithelioma, characterized by a dense stroma of fibrous tissue, pervaded by small and infrequent alveoli, which contain heaps of loose epithelial cells and epidermic pearls. The soft, juicy, medullary, or fungoid form of the affection, generally denominated encephaloid, is of the same nature, but its stroma is more delicate and more vascular, and the loculi larger, while the cells are the seat of granular and fatty metamorphosis and disintegration. In many specimens the latter assume a cylindrical shape, when the mass presents the minute appearances afforded by cylindrical epithelioma of the gastro-intestinal mucous track. Other varieties of carcinoma are almost unknown.

Though malignant growths of the bladder usually proceed very rapidly, epitheliomata of slow progress are met with. Sir Henry Thompson records the following instance:—[2]

> A preparation which I exhibited at the Pathological Society was from the body of a patient who certainly had been the subject of it for eight or ten years. In his case the symptoms resembled those of stone, only that the slightest degree of movement produced bleeding in the later stages. Injections of nitrate of silver, from half a grain to a grain to the ounce, controlled this tendency remarkably, and enabled him to walk a mile or two without hemorrhage. After death the same deposit was found in one kidney.

Sarcoma is one of the rarest diseases of the bladder. Heath[3] records the case of a woman, aged 39, whose bladder was found largely occupied by a villous growth situated on a hardened base which proved to be a round-celled sarcoma. Like carcinoma, sarcoma of the bladder may be primary or secondary; it may be round-celled or spindle-celled, and may assume, in the course of its growth, an appearance not unlike that of a papilloma. Commenting on the asserted infrequency of these tumors, Dr. Stein[4] remarks, "seeing the resemblance between round-celled sarcoma and encephaloid cancer in regard both to their clinical and physical characters, and in the absence of microscopical data, we are with Gross in the belief, that probably many tumors formerly described as encephaloid cancer, belonged to the variety of soft sarcomata."

When undergoing ulceration, malignant tumors of the bladder, by throwing out excrescences, sometimes assume an appearance not unlike that of ordinary villous growths, whence the term villous cancer has been wrongly applied to them. Cancer of the bladder is seldom seen involving the front or summit of the organ, but usually appears about the neck or trigone, or at the opening of the ureters, and as a rule proceeds with much rapidity. Commencing as a general infiltration of the coats of the bladder, it soon passes on to ulceration. Surrounding organs not unfrequently become infiltrated, and death ensues from perforation and urinary infiltration, or from exhaustion. The disease in its early stages is often obscure, sudden and considerable discharges of blood being the only symptom. Then cystitis comes on, and, with other signs of ulceration, cells and even fragments of the tumor have sometimes been found in the urine. Microscopical examination of these has thrown light on the case, but this evidence is perhaps hardly trustworthy further than as showing that structural disintegration is going on. Exploration of the bladder with the sound, although it often aggravates the symptoms, generally adds some evidence as to the presence of the disease. Lymphatic glandular enlargement may be detected in thin subjects. Pain is generally referred to the loins, and there is more or less interference with micturition. The cancerous cachexia is often well marked. Where cancer involves the bladder by perforation from some other organ, such as the rectum, when it ulcerates from the bladder into the bowel, the patient's condition becomes an extremely distressing one. Whilst urine enters the rectum, flatus and feces find admission into the bladder, and the most painful symptoms result.

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[1] Op. cit., p. 143.

[2] Holmes's System of Surgery, vol. iv. p. 900.

[3] Medical Times and Gazette, vol. ii. 1879.

[4] Study of Tumors of the Bladder, p. 35. New York, 1881.

Treatment.—In the management of these malignant affections, there is, unfortunately, little to be done but to palliate with opium or other sedatives, given in sufficient quantities to assuage pain. Chian turpentine has been recently advocated by Dr. Clay, of Birmingham,[1] for the treatment of vesical cancer, accompanied with hemorrhage, but it does not appear that much benefit has been derived from its use.

When by a cancerous ulceration the bladder and rectum have been made to communicate, the question of lumbar colotomy may be entertained. As a rule, much relief has followed by diverting the flow of feces, and by thus preventing the two excretions from falling into a common cloaca. In certain cases of cancer of the rectum, where, from the vesical tenesmus and cystitis, it is evident that the bladder is about to be involved in the cancerous extension, it is well to anticipate by colotomy the formation of a communication between these viscera. In this way much suffering may be saved, though the ultimate result is unchanged.

From the study of observations and statistics relating to tumors of the bladder, Dr. Stein[2] has formulated the following conclusions:—

1. In a few remarkable instances, in the case of women, apparent recovery seems to have resulted from a spontaneous expulsion of growths from the bladder. But in general it may be said that tumors of the bladder, if uninterfered with, are inevitably fatal; and, although they may exist for several years without creating much distress, a fatal termination almost invariably ensues in a few weeks or months from the outbreak of active symptoms.

2. Death results most frequently from hemorrhage, and from the effects of mechanical obstruction to the outflow of urine. Hence, the indication would be to remove the growth while the general condition of the patient was yet favorable for an operation; before the subject had become exhausted from loss of blood, or the kidneys and bladder had become so much diseased as to make recovery impossible, even in the event of the successful extirpation of the growth.

3. In women, because of the accessibility of the bladder to direct exploration, there is no excuse for temporizing, and the surgeon should lose no time in acquiring an exact knowledge as to the existence, nature, etc., of the tumor, and, if practicable, should attempt its removal as early as possible.

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[1] Lancet, March 27, 1880.

[2] Op. cit., p. 93.

4. The results thus far attained by surgical interference, in the cases of women, could scarcely be more satisfactory, and, excepting one instance in which the bladder was accidentally perforated, it does not appear that the fatal termination was precipitated by the operation in any of the cases.

5. In the male, the propriety of operative interference must necessarily always be a more serious question, because of the occasional uncertainty of diagnosis, and because of the gravity of the undertaking necessary for the removal of the growth. Nevertheless, the results thus far attained by operation are most encouraging, and in every way justify a repetition of the same.

6. From a number of autopsies, we learn that the successful operations might have been multiplied, first, in those cases in which no operation was attempted, although the growths could have been easily removed, and with apparently every prospect of success; and, again, in those in which the operation was too long deferred, and which, it is reasonable to assume, would have terminated successfully had the same been undertaken at an earlier period.

7. Given a positive diagnosis of tumor, the absence of severe secondary symptoms should be no excuse for deferring the operation. On the contrary, the earlier the growth is removed the better the prospect of complete recovery. With a healthy bladder and kidneys, cystotomy is not so dangerous an operation as to warrant any delay.

8. Evidence strongly pointing to the existence of a tumor, with severe catarrhal symptoms, or with spasm of the bladder and much suffering, will often justify an operation; for if a tumor be found, its extirpation will afford the only chance for life; and if no growth exist, or the bladder be occupied by an irremovable cancer, the cystotomy may at least afford temporary relief from suffering.

In concluding this description of tumors of the bladder, I wish to lay stress on what Professor Volkmann speaks of as "the bimanual exploration of the bladder." The following is an account of the method, from Mr. Coulson's work:—[1]

> This is effected by passing two fingers of the left hand as far as possible into the rectum, the patient being under the influence of chloroform. An assistant places both hands above the symphysis, and makes pressure downwards and backwards towards the rectum. When the adipose tissue is not very abundant, and the bladder nearly empty, the superior fundus of the organ is brought near to the fingers. If anything abnormal is felt, the surgeon passes his right hand carefully under the hand of the assistant, and endeavors to ascertain more closely the nature of the object. By this plan Professor Volkmann asserts that he has been able to detect the presence of a calculus no larger than a bean. The manipulation must, however, be conducted as gently as possible. In one case it was evidently the cause of ecchymoses, found after death, in the coats of the bladder.

The introduction of the hand into the rectum for the examination of the bladder has recently been employed. It is a practice which can only be adopted under very exceptional circumstances. Few surgeons possess a hand sufficiently delicate and tapering to permit of their practising this manipulation without inflicting considerable damage; though Dr. G. Simon[2] asserts that in no instance has permanent incontinence of feces been the result.

For examining the interior of the bladder, we are provided with a variety of sounds and other instruments which it will be unnecessary to describe here.

TUBERCLE OF THE BLADDER.

Tubercle of the bladder is to be included among its rarer affections. It is most frequently met with in adult males between the ages of twenty and forty-five years. It is generally accompanied with similar deposits in other viscera, but its independent existence in the genito-urinary organs has been noted sufficiently often for its being specified as forming one of the exceptions to the well-known law of Louis, according to which tubercles are to be found in the lungs if they are present elsewhere in the body. Hence Guibhard[1] classifies cases of this affection as either primary or secondary. The deposit takes the form of miliary tubercles, which are observed chiefly about the neck and base of the bladder. As a rule, the disease appears to extend in the course of the urinary flow—downwards from the kidneys. Coalescence of the various deposits occurs, the mucous membrane breaks down, ulceration follows, and before death takes place large portions of the lining membrane are entirely removed. The disease is of slow progress, and generally proves fatal by its extension to other parts of the urinary tract, or by pulmonary complications. Perforation of the bladder followed by fatal peritonitis as a termination of this disease has been but rarely observed. Such a case is recorded by Sir Prescott Hewett,[2] where both an anterior and posterior perforation took place into the rectum. Where repair has followed tubercular ulceration of the bladder, a cretaceous cicatrix has sometimes been the result, a circumstance which has led to the suspicion that the patient was suffering from stone.

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[1] Op. cit., p. 31.

[2] Archiv für klinische Chirurgie, Bd. xv. S. 1.

The *symptoms* of vesical tuberculosis are in some respects similar to those occasioned by a vesical calculus, and the absence of such a cause for the symptoms, as determined by the sound, is of considerable value to the surgeon in arriving at a diagnosis.

Amongst the earliest manifestations of the disease, it has been pointed out[3] that attacks of premonitory hæmaturia are frequently observed. Aching or burning pain in the hypogastric region, with pain and tenderness referred to the neck of the bladder, are often complained of. More or less pain usually precedes as well as accompanies the act of micturition, and there is the greatest degree of comfort when the bladder has been just emptied, though the expulsion of the last few drops often provokes most distressing spasm. As the viscus refills, the desire to evacuate its contents returns, whence the disorder is generally accompanied with considerable irritability and vesical contraction. Dilatation of the ureters is almost invariably met with in these cases; in one instance of this kind that came under my notice, the ureters were so dilated as to render them capable of acting as reservoirs for urine, the bladder being found studded with tubercle, and so contracted as to resemble a rudimentary organ. The urine is more or less purulent, often contains blood, and sometimes shreds of disintegrated tissue. The use of the sound is generally followed by hemorrhage, but it may reveal the existence of some irregularity in the lining membrane of the organ. As the disease advances, it is often accompanied with considerable variations of temperature, which, together with the presence of the other symptoms referred to, and the proved absence of stone, may be said to constitute the points on which a diagnosis is to be founded.

In the *treatment* of this affection, regard must be had to its diathetic character. It is the local manifestation of a constitutional disorder. Recourse must be had to those general measures which are recognized as being indicated when tubercle is present in any organ of the body. Locally, soothing measures, directed to the allaying of pain and irritation, are those which experience commends. For this purpose a milk diet, in connection with the use of anodyne suppositories, will be found most serviceable. Where there is hemorrhage from the ulcerating surfaces, the use of a weak injection of nitrate of silver (gr. ½–f℥j) has proved of much value, although as a rule, after the diagnosis has been made, all instrumental interference with the bladder is to be avoided.

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[1] Étude sur la Cystite Tuberculeuse. Paris, 1878.

[2] Trans. Clin. Soc. Lond., 1874.

[3] Tapret, Étude clinique sur la tuberculose urinaire. Archives Générales de Médecine, Mai et Juillet, 1878. Bierry, De la Tuberculose Primitive des Voies Urinaires. Paris, 1878.

Bar at Neck of Bladder.

An impediment to micturition is sometimes occasioned by a condition to which the term "bar at the neck of the bladder" has been assigned. Though occurring independently of any enlargement of the prostate, it is generally associated with it. A careful analysis of recorded cases warrants the conclusion that at least three varieties of the affection may be described, namely: (1) spasmodic, (2) mucous, (3) muscular.

A *spasmodic* barrier has long been recognized, chiefly by French authorities,[1] under the term *contracture du col vésical.* It may be found where no enlargement of the prostate exists, and appears to consist of an incoördinated or spasmodic action of some of the muscles engaged in the act of micturition. It is almost invariably met with in persons of a rheumatic or gouty disposition, who pass highly acid or otherwise disordered urine. Hence its cure lies in the treatment of the diathetic condition which leads to its production. In addition to the ordinary remedies employed for gout and rheumatism, advantage may often be obtained from a course at certain watering places; of these may be mentioned Vichy, Vals, Contrexville, and Evian. When the exciting cause of the spasm has been removed, much benefit may be derived from the application to the prostatic urethra of a solution of nitrate of silver (gr. ij–f℥j), for the purpose of removing the extreme sensitiveness which sometimes remains.

The other two varieties of bar I have never seen apart from enlargement of the prostate, of which condition I regard them as results. Mr. Guthrie appears to have been one of the first to observe these changes, and to suggest means for their relief. The formation of a *mucous bar* may be well studied in certain varieties of symmetrical enlargement of the lateral lobes of the prostate. In some of these specimens, a distinct, crescentic duplicature of mucous membrane can be seen guarding, so to speak, the vesical orifice of the urethra; its connection with the lateral prostatic enlargements may often be rendered very obvious by separating the lobes after the urethra has been opened along its roof, when greater or less distinctness is given to the bar according to the amount of separation effected. In fact, a bar may in in this way be artificially produced which does not exist in the undisturbed relations of the parts. That in some cases an impediment to micturition independent of prostatic hypertrophy may be thus produced, is apparent from an examination of the internal meatus before a section of the urethra has been made.

This variety of bar may exist when rectal examination affords little evidence of prostatic enlargement, the reason being that the latter consists for the most part of a lateral expansion of the gland, which is only indicated by some increase in its breadth, and possibly by a slight obstacle, or hitch, as the catheter reaches the prostatic urethra. It is almost impossible to disassociate it in its symptoms from the hypertrophy of which it is a result.

The third variety, or *muscular bar*, consists of an aggregation of some of the muscular fibres which run transversely across the trigone behind the prostate. Occasionally the elevation is so marked that it forms, as it were, two compartments, an upper and a lower one, in the wall of the bladder. Although the obstruction is structurally unconnected with enlargement of the prostate, it is rarely seen except in company with it. In explaining the production of this muscular barrier, there are grounds for regarding it as an illustration of a partial hypertrophy of the muscular coat of the bladder. As the prostate enlarges, a pouch often forms immediately behind it, in which urine is disposed to lodge. It is not unreasonable to suppose that, by an increase in the muscular fibres of the trigone, some provision is made, or attempted, for the evacuation of a part of the bladder, which, by the enlargement referred to, is placed at a disadvantage so far as outlet is concerned.

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[1] Delefosse, Leçons Cliniques sur la Contracture du Col Vésical. Paris, 1879.

Treatment.—In reference to the treatment of the two latter varieties, it is, as already stated, exceedingly difficult, if not impossible, to disassociate their symptoms from those of the prostatic enlargement which almost invariably coexists. Guthrie appears to lay most stress, in the diagnosis of this affection, on the detection of an obstacle to the passage of an instrument through the prostatic urethra, in addition to other symptoms of impeded micturition in elderly persons.

Where there are reasons for entertaining the belief that such an obstacle exists, endeavors must first be made to overcome it by the judicious employment of prostatic dilatation, care being at the same time taken to avoid consequences arising from urine being retained and allowed to decompose in the bladder. The form of dilator presently to be referred to in connection with the early treatment of prostatic obstruction, will be found best suited for fulfilling the object now in view.

Where relief is not possible by other means, section of the obstacle by some form of urethrotome, or concealed knife, has been practised and recommended by several surgeons of experience, including Guthrie, Mercier, Teevan, and Gouley. Such operations are not, however, to be lightly undertaken. As this subject will again come under notice in connection with the treatment of enlarged prostate, further reference to it will be for the present postponed. Experience, however, justifies the conclusion that the persistent employment of suitable bougies, where there is reason to believe that some structural barrier exists, such as a band, an enlarged prostate, or both, is capable, in the great majority of cases, of giving permanent relief without resorting to more strictly operative proceedings.

Fissure of the Bladder.

A fissure or crack at the neck of the bladder is an occasional cause of much distress, both to male and female patients; it is most frequently met with in the latter.

The *symptoms* are very similar to those observed when fissure exists at other orifices. There is frequent micturition, with a sensation, often described as resembling alternating dilatation and contraction, at the close of the act, which is very significant. Sometimes a few drops of blood escape after the urine has been expelled, followed by a sharp, stinging pain, referred to the neck of the bladder. The pain varies in degree in the same patient, being usually intense when the urine is highly acid, diminishing in severity as neutrality is approached. Examination of the prostate in the male, and of the neck of the bladder in the female, invariably produces, on pressure, a sharp, lancinating pain, as if a knife were being inserted, which is very characteristic of the affection. Similarly, the passing of an instrument into the bladder is attended with much distress. Occasionally these cases are referred to some gouty or rheumatic affection, and are mistaken for a condition, already mentioned, well known in French literature under the title of *contracture du col vésical.* As the treatment of the latter affection includes the rendering of the patient's urine more or less alkaline, the local symptoms are thereby improved when a fissure exists, a circumstance which is pointed to as confirmatory of the diagnosis. The improvement, however, only continues as long as the alkaline reaction of the urine is maintained. Vesical fissure, though palliated, is seldom cured by such means.

The principles of *treatment* for this affection are much the same as those recognized when fissure is met with elsewhere. A cure is sometimes effected by keeping the urine neutral or slightly alkaline, combined with the occasional application of a weak solution of nitrate of silver (one grain to the ounce) to the prostatic urethra. In other cases permanent benefit is only obtained by establishing a temporary condition of incontinence: this, in the male, may be best accomplished by cystotomy, and in the female, by rapid dilatation of the urethra.

I have performed a lateral cystotomy for fissure, where the suffering of the patient far exceeded anything observed when a stone is present in the bladder, and with complete success.

IRRITABLE BLADDER.

This term has been used as expressing a disease rather than a symptom, and hence some confusion has arisen in the application of therapeutics to the conditions on which it depends. By "irritable bladder," it is meant that micturition is performed unnaturally often, without regard to the number of times that a healthy person should urinate in the twenty-four hours.

There are variations dependent upon circumstances, and to some extent on individual peculiarities, which would render any attempt to indicate the frequency with which urine should be voided, in order to constitute irritable bladder, almost ridiculous; and therefore, unless a person be in some way inconvenienced thereby, he cannot be regarded as the subject of this condition.

Causes.—Irritability of the bladder is generally traceable to one or other of the following conditions, some of which may coexist: nervous influence, habit, reflected action, structural diseases—including tumors and calculous disorders—and an abnormal state of the urine. Unless careful inquiry be made as to the cause of the irritability, treatment must necessarily be empirical.

There can be no doubt that a considerable number of persons trace the irritability of their bladder to purely *nervous causes.* It often happens that individuals, in anticipation of a railway journey, for instance, or other occasion by which their ordinary habits may be interfered with, for days previously empty their bladders on every possible opportunity. In this way a habit is established, which may eventually become very distressing.

Nearly allied to this is the condition so graphically described by Sir James Paget,[1] as "stammering with the urinary organs." Nervousness, and a bad habit combined, are quite sufficient to produce very intractable forms of urinary irritability.

In these cases there are, as a rule, no objective symptoms; the history of the irritability, the circumstances influencing it, and the employment of a process of exclusion, are the points upon which reliance should be placed in forming a diagnosis. In their management, we should not forget that a common-sense explanation in reference to the peculiar dread which the patient has, is often not without avail. The strange vagaries that are sometimes met with under these circumstances, are apt to try the patience of those who have to listen to their narration, and indicate that the head has often more to do with the irritability than the bladder. Such cases are benefited by the various preparations of iron, nux vomica, strychnine, and phosphorus, in addition to other hygienic measures. Persons who have had reason, however slight, for believing that they suffer from stricture, not unfrequently develop irritable bladder. I have seen this condition follow on all kinds of misapprehension in regard to normal acts of micturition; upon the unskilful introduction of instruments undertaken with the object of removing the patient's doubts; or on a groundless dread of inability to void urine, inducing a frequent repetition of the act, which has eventually resulted in the setting up of irritability. It is astonishing how many persons may be completely cured of this symptom by demonstrating to them the ease with which a bougie may be made to enter the bladder.

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[1] Clinical Lectures and Essays.

Irritability dependent on *reflected action* is most commonly met with in children and young persons. An illustration of this cause is furnished by the irritation attending the presence of intestinal worms; and similarly, the cutting of a tooth in a child has been known to produce the same effect. In youths, particularly, and even those of more advanced age, a constant desire to micturate may be kept up by an elongated and contracted prepuce, retaining secretions which have excited local inflammation.

Irritability dependent upon *structural changes* in the urinary organs, *growths*, and *calculous affections*, is a frequent concomitant of those disorders; nor are these causes entirely confined to such diseases of the urinary organs as more commonly come under the notice of the surgeon. Certain forms and stages of purely *renal affections* do not seldom give rise to this symptom.

Similarly, irritation is provoked by *enlargement of the prostate*, particularly at the commencement of the disease. At this stage it would be more correct to speak of it as senile engorgement of the prostatic veins, a condition which often precedes and is mistaken for the structural enlargement of the gland with which we are familiar. The irritability connected with the prostatic engorgement shows itself chiefly at night. The patient is perfectly well during the day, but as soon as he gets into bed he experiences a desire to pass water, which further disturbs his rest by provoking other calls after intervals of varying extent; or it may show itself by inducing a state of more or less priapism, which equally interferes with sleep. During the day, as already stated, the patient is free from irritability; it only occurs at night. In this condition, physical examination with the finger in the rectum, or a catheter in the bladder, frequently fails to detect any signs of prostatic hypertrophy; possibly all that may be noted is a distended or varicose condition of the veins immediately in front of the finger. Provided, as is most usually the case, that there is nothing in the state of the urine to account for this, some very simple expedients are not unfrequently of service in remedying, if not entirely putting a stop to, this symptom. The wearing of warm socks at night, or the use of a hot bottle to the feet, by determining a flow of blood to the legs has often been useful—a fact which leads to the belief that the appearance of this symptom only at night is due to some alteration in the venous condition of the part, by reason of the change in position.

Senile engorgement and hypertrophy of the gland not only follow in succession, but the two conditions frequently coexist. Irritability of the bladder arising from an enlarging prostate, is usually determined without difficulty by physical examination. It will be noticed that the irritability of hypertrophy varies somewhat in the precise mode of its causation. In the earlier stages of the enlargement, especially in gouty subjects passing acid urine, the irritation comes on immediately after the bladder has been emptied, and the desire will remain for an hour or so until the urine has collected, and a water-bed is as it were interposed between the muscular pressure of the bladder and the tender or gouty prostate. Then there is an interval of repose until urine is again passed, when the same process, accompanied by similar sensations, is repeated. The irritability of the subsequent stages of prostatic enlargement is somewhat different in its character, being due to the presence of residual urine, with the chronic cystitis which the pathological state of uncleanliness has engendered. The difference has this import: the former is aggravated by catheterization, as usually practised, whilst the latter is remedied by catheterization, combined with irrigation of the bladder; and conversely, sedatives and emollients give relief to the first-mentioned form of irritability, whilst in the latter, when employed alone, they are worse than useless—they are disappointing.

Irritability of the bladder in children and adults is a usual symptom of *stone*, though it varies much both in kind and degree. There is this anomaly in the vesical irritability of stone, which has often struck me: in most other forms of irritability, a patient gives way to the desire to urinate with, at all events, a prospect of temporary relief; whilst in stone, on the contrary, it is with the certainty of having his suffering added to until urine collects sufficiently to take the pressure of the calculus from off the mucous membrane.

Stricture of the urethra often occasions vesical irritability, either by provoking spasm, or by bringing about structural changes in the bladder, by which its capacity is lessened and its walls are thickened.

Irritability due to *altered and abnormal states of the urine*, is not infrequent, and will necessitate, where there are symptoms to be cleared up, an examination of this excretion. The urine least irritating to the normal urinary passages, is that which most nearly approaches the healthy standard. The low specific gravity of the urine which is passed so frequently and abundantly by hysterical females, no doubt causes the irritability from which they, under these circumstances, almost invariably suffer. Water is more irritating to those passages of the body over which it is not intended to flow, than a saline solution of some density. The abundance of uric acid in the urine of the gouty, undoubtedly explains the extreme irritability of the bladder, and the intense irritation and feeling of weight which these persons experience, and refer to the region of the prostate. Gouty manifestations in the parts behind the triangular ligament, are quite as frequent as the more familiar indication of this diathesis which we meet with in an acute form about the ball of the great toe. The benefit which, in these cases, attends the administration of antipodagric remedies, together with diluents, is most marked. Something similar is seen in individuals who frequently suffer from gouty affections of the skin, such as eczema. Cases are not uncommon of gouty patients who successively suffer from eczema and irritability of the bladder. Neither is present in any marked degree at the same time, and the aggravation of one seems to be the alleviation of the other.

There is a form of irritability—for such it certainly is, though manifesting itself by morbid actions rather than by morbid sensations—in which the bladder is not under proper control. Reference is made to the nocturnal incontinence of young children; this may be provoked by any of the causes previously mentioned, which are to be carefully sought for. This state is not to be mistaken for the dribbling or running over from a distended bladder, which, by atrophy of its muscular coat or other similar cause, is prevented from expelling its contents. The incontinence of childhood is a very common and sometimes troublesome complaint, and when not due to any of the causes indicated, is probably connected with an atonic condition of the walls of the bladder, manifesting itself when the action of the voluntary, controlling muscles of micturition is temporarily in abeyance, as in sleep. In the management of these cases, reliance is chiefly to be placed upon inculcating habits of regularity, combined with medicinal treatment. Among drugs which may be mentioned, are belladonna and its alkaloid, atropine. These seldom fail when employed on the principle "that chronic diseases need chronic therapeutics." Various mechanical means have been adopted for the treatment of this affection, such as the employment of the *jugum*, or urethral compressor, and closing the meatus with collodion, as suggested by Sir Dominic Corrigan.[1] Of these, the latter is the least hurtful, and may occasionally, when other means have failed, be resorted to with advantage.

Attention to the diet is very necessary in these children; irregularities, both in eating and drinking, are often attended with a condition of urine that is likely to provoke incontinence. A strictly milk diet has, in some instances, been sufficient to effect a cure.

There is a form of irritability of the bladder which is frequently met with, especially in highly intelligent and sensitive children, at about the age of ten or eleven years, when they are entering upon the sterner forms of educational study. On examination of the urine it will be found loaded with phosphates. In remedying this condition, the bromides, in combination with opium, will be found invaluable. Care must be taken that the child be not submitted to an undue amount of nervous tension by reason of his educational studies.

Lastly, it must be remembered that irritability of the bladder is a symptom which is by no means confined to the male sex; it is frequently met with in females.

In the same manner as already insisted on, the causes of the irritation must be carefully searched out, not forgetting that in females the condition of the uterus or of the rectum frequently affords a sufficient explanation. There is a cause of irritability and spasm of the bladder in females, which, though not uncommon, is not sufficiently recognized. I refer to fissure at the orifice of the urethra, which is enough to account for the sensitiveness complained of. Failing its cure by a few applications of nitrate of silver, rapid dilatation of the urethra is generally found sufficient to afford relief.

We have been accustomed to regard an irritable bladder as a purely functional disturbance, as far as this viscus is concerned, and for the most part it is so; but we must not forget that the constant contraction of the bladder may produce changes behind it, which follow as a consequence of the backward urinary pressure, and of which dilatation of the ureters and of the kidney are examples. These conditions have been noticed where there has existed nothing to account for them, other than the obstacle to the escape of urine which a constantly contracting bladder has presented.

Injuries of the Prostate.

Wounds and ruptures of the prostate from accident are, by reason of the manner in which the gland is protected, of rare occurrence. Occasionally a subacute form of prostatic inflammation is provoked, especially in gouty subjects, by contusions such as follow violent concussions of the perineum, as from the pommel of the saddle in riding. The tenderness thus produced generally subsides with rest, in the course of a few days. Wounds of the prostate are usually inflicted in the course of some surgical procedure, as in lithotomy, or by the penetration of a blunt instrument, as in forced catheterization for prostatic obstruction.

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[1] Dublin Quarterly Journal of Medical Science, February, 1870.

Lithotomy-wounds of the gland for the most part heal kindly, and are seldom followed by urinary fistula or by any impediment to micturition. Some cases are recorded in which it is probable that contraction of the prostatic cicatrix has resulted in interference with the action of the vesical sphincter, and has caused a more or less permanent condition of urinary incontinence. In Dr. Goodhart's[1] case, the prostate, eleven years after a lithotomy, was found much distorted by a large and puckered cicatrix. From an examination of this specimen, the incision into the neck of the bladder appears to have been very extensive. The patient had suffered from incontinence since the operation. As long as the incision is kept within the limits of the proper structure of the prostate, but little constitutional derangement is likely to be occasioned by it. Where, however, the wound extends so as to divide the capsular investment, the most serious complications, including pelvic infiltration, cellulitis, and peritonitis, are likely to follow. The proper incising of the prostate is one of the most important steps in the operation of lithotomy. Lacerated wounds and ruptures of the prostate have been caused by what is termed "forced catheterization," undertaken for the relief of retention of urine, when the enlarged gland has formed the obstacle to micturition as well as to the introduction of an instrument into the bladder. Though this proceeding has received the sanction of some surgical authorities, and has been frequently practised with impunity, it is one which cannot commend itself to any scientific practitioner of the present day, except under special circumstances. The consequences which sometimes follow the forcing of a catheter through any portion of the prostate, are very disastrous. Not only may the bladder become in this way filled with blood, which has no way of escape, but the damage occasioned to the surroundings of the gland by the force necessary to drive a blunt catheter through such an obstacle, may cause fatal pelvic cellulitis.

Improved instruments, as well as improved methods of tapping the bladder, presently to be described, have removed the necessity for a proceeding which can hardly be regarded as a legitimate one.

When hemorrhage into the bladder follows laceration of the prostate by the catheter, it may be sufficient in amount to form a hard, globular tumor, immediately above the pubes, which is exceedingly painful on pressure. When this is accompanied by an urgent and ineffectual desire on the part of the patient to micturate, relief may be given by the introduction of a catheter with a large eye, and having for its stylet an accurately fitting gum-elastic bougie. An instrument similar to Clover's catheter for removing débris from the bladder answers the purpose exceedingly well. Aided by the injection of tepid water, the clot may in this way be broken up and discharged. Or the aspirator may be employed above the pubis. From an observation of Dr. Weiss,[2] it appears that not only urine but clots can be removed through a comparatively fine needle.

In a case of hemorrhage into the bladder after forced catheterization, where it was found impossible to reintroduce the instrument, rather than repeat the proceeding a median cystotomy might be practised, with the subsequent introduction of Mr. Buckston Browne's[3] tampon, as used for bleeding after lithotomy. Where hemorrhage from the prostate into the bladder is unattended, as it most frequently is, with symptoms either of retention or local distress, no interference will be necessary. The clot eventually becomes disintegrated by the urine, and is then carried off without doing further harm.

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[1] Trans. Path. Soc. Lond., 1876.

[2] American Clinical Lectures, vol. ii. No. 8.

[3] Lancet, September 15, 1879.

Prostatitis and Prostatic Abscess.

Of all the complex structures which together constitute the genito-urinary tract, from the kidneys downwards, the prostate gland may be regarded as least liable to attacks of acute inflammation; and in this respect it seems to serve a useful purpose, in acting as a check against the extension of an inflammation from the much-exposed and susceptible urethra below, to the more vital organs above. Structural differences thus play an important though not sufficiently appreciated part, in limiting the progress of a variety of pathological actions, which would otherwise, by continuity, spread almost unrestrained.

Acute Prostatitis.—The term *acute prostatitis* includes two varieties, presenting distinct pathological features, each disposed to pursue a tolerably definite course, and each determined by different circumstances. The one is an acute, follicular prostatitis; the other a general, or parenchymatous, inflammation of the gland.

Acute follicular prostatitis is not uncommon. It is most frequently seen as a complication of gonorrhœa. A person suffering from the latter affection suddenly finds the discharge either diminished in quantity, or altered in character, and this is followed by a sense of weight or uneasiness in the perineum. On examination, the gland is found to be hot, tender, and swollen. Micturition becomes frequent or impeded, in accordance with the extent to which the bladder structurally sympathizes, or the swollen prostate obstructs. In some instances there is complete retention. In these cases it will be found that the inflammation is almost entirely confined to the follicles of the gland. These may suppurate individually, or limited abscesses may form by the fusion of two or more of the obstructed follicles. "There is never," as Bumstead[1] remarks, "at the outset, one abscess of considerable size. Such occurs only by the coalescence of a number of small ones situated in the follicles. Meanwhile the muscular tissue which constitutes so large a proportion of the prostate is unaffected, except that it is in a constant state of contraction, thereby inducing urethral and rectal tenesmus." The follicular is the simple form of acute prostatitis. Though painful and distressing whilst it lasts, the symptoms are not usually protracted, and the prognosis is favorable. Recovery most frequently follows by resolution, suppuration being the exception and not the rule. When suppuration does take place under these circumstances, it is to be inferred rather than demonstrated, for rigors are often absent, and the most careful examination with the finger in the rectum fails to discover fluctuation, though an escape of pus by the urethra may almost immediately follow the introduction of a catheter, rendered necessary for the purpose either of completing the examination or of relieving retention.

The other form of prostatitis—*acute parenchymatous or general prostatitis*—is a much more serious disorder. The whole gland within the capsule seems to be at one and the same time invaded by inflammatory action. Suppuration usually rapidly supervenes, and unless treatment be prompt and decisive on the first appearance of fluctuation, as revealed by rectal examination, the most serious results, both to structure and life, are likely to follow.

This form of prostatitis is rare. I can find no specimen of the kind described in the Transactions of the London Pathological Society since 1865, nor do I see any reference to it in the proceedings of the Clinical Society, since its commencement. Cases of the disease, however, will be found scattered throughout the medical journals, and the experience of all who have seen much of this class of disorders will include some examples.

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[1] Treatise on Venereal Diseases, 4th ed., p. 170.

At the outset, it is not easy to determine which of the two conditions referred to we have to deal with. The exciting causes are in either case much the same, and we must look for other circumstances to determine whether the inflammation will be limited to the follicles, or will involve *en masse* the entire gland. We shall find that the conditions which favor the latter are such as, did they happen to be present when any part other than the prostate was inflamed, would render the occurrence of suppuration if not of gangrene probable. Parenchymatous prostatitis for the most part occurs in persons of a broken-down constitution. It is occasionally seen in tuberculous subjects who have contracted gonorrhœa. I have had reason to suspect that previous tuberculosis of the gland had determined the result. Again, it is seen in prostates that have been rendered unhealthy by long standing stricture and cystitis, on the application of some fresh exciting cause, such as a gonorrhœa. Under these circumstances suppuration may be rapidly induced.

Gangrene as a result of prostatic inflammation is exceedingly rare, but it occasionally occurs. I have seen it after lithotomy in a very unhealthy adult.

There are two conditions simulating prostatitis, which have led to the impression that this affection is far more common that it really is. The first is inflammation and suppuration around the membranous portion of the urethra, as a consequence of urethritis; and the second, inflammation and plugging of the veins which constitute the prostatic plexus. I have seen many instances of the former, where inflammation and suppuration around the membranous urethra have led practitioners into the belief that the case was one of metastasis of gonorrhœal inflammation from the urethra to the prostate gland. And the points of resemblance are by no means isolated—there is in fact a remarkable likeness between the two conditions. In both there is a cessation of, or alteration in, the urethral discharge; in both there is a feeling of uneasiness and weight about the perineum; in both there is some difficulty in micturition, amounting perhaps to retention; and in both there is some tumefaction to be felt, and much distress is occasioned, by introducing the finger into the rectum. So painful is this to the patient, that it often leads to an imperfect examination being made, and hence, from not exactly fixing the position of the tumefaction, an error in diagnosis arises which might be avoided.

It must, on the other hand, be remembered that in inflammation and suppuration around the membranous urethra, although the part lies between the layers of the perineal fascia, there is still more or less perineal tumefaction, and that matter formed there may make its way forward and be discharged through a perineal opening.

In acute prostatitis these conditions are not present, whilst in deep-seated peri-urethritis they are usually observed. Considering the relations of the prostate, and the denseness of the fascia in front of it, perineal tumefaction is not to be expected as a consequence of prostatitis, any more than swelling in this locality is to be looked for in connection with senile hypertrophy of the gland.

The other condition simulating prostatitis is rare, and, as it is also curious, I will briefly describe the appearance in two cases recently under observation. The primary lesion was plugging of the dorsal vein of the penis, followed by rapid œdema of the prepuce. In the course of a few days each patient complained of perineal weight, frequent rather than painful micturition, and great uneasiness referred to the neck of the bladder, which led in each case to its being suggested that the prostate was inflamed. Both patients were gouty; in one the œdema was attributed to gonorrhœa, in the other to the use of a strong injection. Though in both these patients there were some grounds for believing their prostates to be inflamed, it was determined by careful rectal examination that the vesical pain and irritability were not due to such a cause, but to an extension of the venous thrombosis to the prostatic plexus.

Treatment.—At the commencement of an attack of acute prostatitis, nothing gives greater relief than the free application of leeches to the perineum. Some practitioners employ ice by the rectum, but, as a rule, warmth, in the form of hot fomentations and poultices applied over this region, is preferable. Purgatives of all kinds are to be avoided, inasmuch as every movement of the parts greatly aggravates the sufferings of the patient.

If a distended rectum require evacuation, a copious warm water enema will be found to answer the purpose. In threatened suppuration of the prostate, advantage will be found from injecting hot water into the bladder through a soft rubber catheter. Such a measure diminishes the accumulation of mucus within the prostatic urethra, and thus prevents the formation and collection of matter in the follicles. Opium will be found essential in sustaining the powers of the patient, otherwise soon worn down by the irritation and pain which to some degree are always present. By means of alkalies the urine must be kept almost neutral.

The occurrence of suppuration is to be carefully looked for. Experience warrants the conclusion that any formation of matter in the gland which is not appreciable to the finger in the rectum, may with safety be left to evacuate itself spontaneously, which it will do by the urethra. When fluctuation is detected by rectal examination, a perineal incision becomes imperative. This can be best made in the median line, with a straight, long-bladed finger-knife, the forefinger of the opposite hand being retained within the bowel. Unless the abscess be opened effectually, matter will most probably find its way into the rectum, and a permanent fistula be the result; or it may burrow in other directions, in any case with more disastrous results than are likely to follow from perineal evacuation by the surgeon. Rectal puncture has been practised, but is not to be recommended; incision, in the case of an acute abscess, is, as a rule, preferable.

If there is one point upon which stress should be laid, as bearing both on the diagnosis and treatment of these cases, it is the importance of a thorough examination of the gland by the rectum. Pain, and the tension of the part, often cause this to be imperfectly conducted, and an error in diagnosis is the result—an error, too, which the use of an anæsthetic would render almost impossible.

It must not be forgotten that abscesses, sometimes of very large size, may form within the limits of the prostate without giving rise to those symptoms which they usually provoke. Cases are recorded in which prostatitis has supervened upon attacks of gonorrhœa, and has terminated in suppuration and death, with complete absence of the rigors and other ordinary symptoms of abscess.

Chronic Prostatitis.—Cases of chronic inflammation of the prostate are sometimes met with, the gland remaining tender for considerable periods of time after all acute symptoms have passed away. This condition is not unfrequently complicated with subacute orchitis, the latter being aroused by extraneous sources of irritation, such as the passing of a catheter, its retention in the bladder, or even the passage of urine of a highly acid character.

Chronic prostatitis is best relieved by the application of blisters to the perineum, and by the internal administration of iodide of potassium. Care should be taken to ascertain whether the urine is in its composition of a nature to irritate the parts over which it flows, and, if so, to correct this condition.

PROSTATORRHŒA.—This term has been used to designate a gleety discharge for which the prostate is regarded as responsible. I believe that it is often a remote consequence of follicular prostatitis, the follicles of the gland remaining permanently in a more or less dilated condition, which is favorable both to the production and maintenance of discharge on very little provocation. In enumerating the various exciting causes of this affection, Professor S. W. Gross[1] observes that they are incapable of lighting up the affection independently of some pre-existing inflammation of the prostatic urethra. The disease consists essentially in the flow of a clear viscid fluid from the urethra, following any kind of strain. The absence of spermatozoids serves to distinguish this fluid from seminal discharges.

The *treatment* consists in the removal, as far as possible, of the general and local causes of excitement. Dr. S. W. Gross speaks favorably of the internal administration of atropia. As the disease is maintained by an atonic and dilated condition of the orifices of the prostatic ducts, cold sitz-baths, the injection of a solution of nitrate of silver (thirty grains to the ounce), and blisters to the perineum, are means which, as a rule, will be found serviceable. The gloomy view which these patients sometimes take of their malady, considerably adds to the difficulty of curing them.

PROSTATIC IRRITATION.—There are certain affections of the neck of the bladder which will be best referred to under this heading. Of these, the most common is that met with in gouty subjects, where the irritation is so intense as almost to amount to an inflammation. Many cases which are described as neuralgia of the prostate, are nothing more than illustrations of this affection.

It occurs most frequently in individuals who, although possessing the gouty diathesis, either hereditary or acquired, have previously remained free from the ordinary indications of the disorder. Like gout affecting the great toe, the paroxysm usually comes on at night, and is referred to the neck of the bladder, which is often described as feeling like a hot ball. Though painful, micturition is irresistible, and spasmodic sympathetic pain often attacks one or both testicles, which are sensitive to the touch. The prostate is sensitive to rectal examination. The urine, invariably highly acid, deposits lithates, and contains mucus in excess. During the daytime the symptoms remain in abeyance, to recur at night with unabated force. The disorder usually merges into a chronic form of irritation, which is sometimes very persistent. I believe that the affection is provoked in gouty subjects by the extremely irritating nature of the urinary secretion which is in contact with the gland.

After an acute attack of this kind, the prostate is often left preternaturally sensitive for a considerable period, and in consequence of this the patient dreads to exercise pressure upon it by completely emptying his bladder. Hence he involuntarily retains a water-bed of urine, so to speak, behind his prostate, for the purpose of protecting it from pressure. This I have frequently determined by passing a catheter. Retention of urine under these circumstances is not only a fruitful source of chronic cystitis, but is also favorable to the production of vesical calculi.

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[1] On Impotence, Sterility and Allied Disorders of the Male Sexual Organs, p. 163.

In the *treatment* of irritable bladder due to prostatic gout, there are one or two points to which prominence should be given. In the first place, I have never seen it occur except where the urine has been found highly acid, and where crystals of uric acid have been present in abundance. The administration of alkalies in this condition can hardly be regarded as other than a natural expedient. It has been asserted that the neutralization of the urinary acid by the alkaline medicine, is little else than masking the disease, as the cause of the acidity still remains untouched. Whether this be so or not under all circumstances, I do not purpose discussing, but it seems reasonable to infer that the artificial diminution of the acid is likely to alleviate the feeling of burning and spasm which attends each act of micturition. Further, the alkalies generally have the effect of altering the form of the uric acid crystals. I have observed that in persons passing certain crystals, the degree of vesical and urethral irritation has been intense, whilst in others, where the form of crystal has been different, the pain and irritation have been slight. The administration of alkalies not only often effects a change in the shape and quantity of these crystals, but also diminishes the severity of the symptoms to which their presence has given rise. The use of a catheter in these attacks is not desirable, unless there are reasons to believe that there is a considerable accumulation of urine in the bladder, when a rubber instrument may be passed.

In the treatment of this form of irritable prostate, both in its acute and chronic stages, reliance must chiefly be placed on the correction of the state of the urine, and on the employment of remedies which relieve the ordinary manifestations of gout. Patients who are in the habit of suffering from attacks of this kind, generally derive benefit from a periodical residence at such watering places as Vichy, Fachingen, or Buxton.

HYPERTROPHY OF THE PROSTATE.

Hypertrophy or enlargement of the prostate gland, is a condition which is frequently met with in males who have passed their fifty-fifth year. It may be stated generally that the number of persons thus affected amounts to somewhere about one-third of those living after the specified age has been reached, though it is not implied that all who are affected are necessarily conscious of the change that has taken place. Indeed it often happens, as will be presently shown, that some very large prostates occasion few or no symptoms of their presence. The alteration which takes place in the size of the gland is of the nature of a hypertrophy or overgrowth, that is to say, no fresh structural element is imported. The analogy with ordinary hypertrophies, however, ends here, as, unlike hypertrophy of the bladder or heart, the change in the prostate is apparently purposeless.

The hypertrophy may involve either the whole or a part of the gland, or it may be in the form of an isolated growth imbedded in a normal prostate, or, what is still more common, in one that has already undergone some hypertrophic change. These isolated tumors are structurally identical with adenomas, such as are found in the breast, and to these they have many points of resemblance. Whether occurring as independent tumors, capable of being readily separated from their surrounding connections, or as general or partial enlargements, the mass presents, structurally, indications that it consists of varying proportions of the component elements of the normal organ.

There has been much speculation as to the causes by which this change is brought about, but as yet no very definite conclusion has been arrived at. It is probable that a solution will be found in the application to the generative functions, of the laws which Paget has formulated as the determining causes of hypertrophies, or overgrowths, in other parts of the body. These are, (1) the increased exercise of a part in discharge of its natural function, (2) an increased supply of healthy blood, and (3) an increased accumulation in the blood of the particular materials which such part appropriates in its nutrition, or for secretion. It has been objected that an explanation which endeavors to connect prostatic enlargement with sexual vigor must fail to suffice, inasmuch as the growth does not commence at a time when the reproductive powers are active, but rather when they are on the decline. That the withdrawal of a portion of that function of the prostate in which it has been the most vigorously engaged, should be followed by a continued activity in which growth is substituted for secretion, is not, I consider, pathologically illogical; whatever may be the explanation, my own observation leads me to believe that prostatic hypertrophy is almost always met with in persons whose sexual propensities have been well, if not excessively, maintained.

Symptoms.—In a certain proportion of cases, hypertrophy of the prostate is unattended by any special symptoms pointing to its presence. In fact, the disorder does not come under our notice, except in connection with some derangement in micturition. Even very large prostates have failed to indicate their existence otherwise than by causing a mechanical obstacle to defecation. The deductions which may be drawn from cases in which the prostate is large, but does not obstruct micturition, will be referred to in connection with its early treatment under those circumstances.

More commonly an enlargement of the prostate shows itself by some interference with the act of micturition, and when this occurs for the first time in a man after he has passed his fifty-fifth year, it is very significant of the affection. The first signs have reference usually to the size of the stream of urine, to the patient's diminished power of projecting it, and to the frequency with which the act of micturition is performed. As time goes on, the urine becomes altered in character; it is disagreeable to the smell, and often offensively ammoniacal; large quantities of mucus are voided with it, and cling tenaciously to the vessel into which it is received.

These symptoms are divisible into two classes, (1) those first enumerated, which indicate that the prostate is impeding micturition, and (2) those which result from the decomposition that naturally takes place in a bladder containing stagnant urine. Hence in nearly all cases of advanced prostatic hypertrophy, we have the symptoms of varying degrees of cystitis, superadded to those of obstruction.

In the later stages of the disease, these combined conditions bring about a state of the most extreme misery. The bladder becomes absolutely intolerant of urine, and the act of micturition, or the passing of a catheter, has to be performed so frequently, both by night and by day, as to prevent the patient from obtaining sufficient, continuous rest. Under these circumstances, a condition of ammonæmia is frequently set up, which almost invariably brings about a fatal termination. Symptoms such as these naturally suggest a careful physical examination of the prostate from the two passages with which it is in relation, namely, the urethra and the rectum.

By digital examination of the gland from the rectum, we shall be able to ascertain whether in this direction there are evidences of its increased growth. Though we cannot here detect any, we are not therefore to infer that none exists, inasmuch as instances are frequent of prostatic enlargement taking place towards the vesical aspect of the gland, which is undetectable from the bowel; and conversely the gland may be considerably enlarged towards the rectum, and yet, as far as the urethra is concerned, as demonstrated by the use of the catheter, no obstacle may be occasioned.

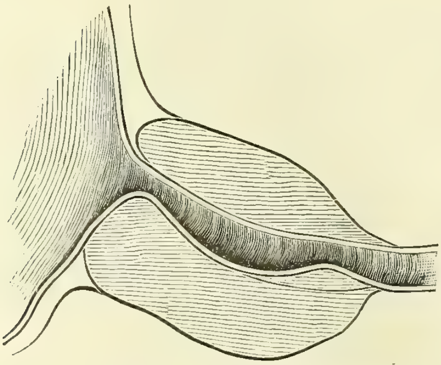
Before proceeding further, it will be proper to consider, (1) the circumstances which explain non-interference with micturition in some cases of prostatic hypertrophy, (2) the changes which take place in the prostatic urethra as a consequence of prostatic hypertrophy, with special reference to the expulsion of urine from the bladder. Inquiry in these two directions will be found not unfruitful in leading to conclusions which will be of value when the treatment of this affection comes to be considered. It may be remembered that one of the pleasures connected with pathological inquiries, such as this, lies in the endeavor to discover nature's ways and means of making provision against the arrest of function which appears inseparable from the course of certain structural diseases.

(1) From the examination of a considerable number of large prostates which caused no obstruction to micturition, I have observed that there are at least two conditions which may explain the absence of such obstruction. One is where the hypertrophy takes place mainly in the direction of the rectum, in which the relations and dimensions of the prostatic urethra are unaltered:—

Some years ago I was examining an elderly gentleman for hemorrhoids, when I accidentally discovered that the prostate was considerably enlarged towards the rectum. I passed a catheter into the bladder, but could find no obstruction. Not long afterwards this gentleman died from heart disease, and post-mortem examination showed that, although the lower segment of the prostate was considerably enlarged, the prostatic urethra was unaltered. This patient had never had any symptom of impeded micturition.

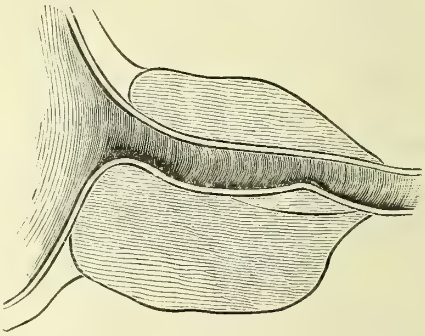
The other condition referred to is, where the prostate as it enlarges leaves channels between the hypertrophic masses, along which urine finds its way uninterruptedly. This lobulated form of hypertrophy is by no means uncommon. It is referred to by Dr. Messer[1] as a condition which will serve to "explain the occasional absence of symptoms of obstruction, in cases where the prostate is known to be considerably enlarged."

Fig. 1288.



Section of normal prostate.

Fig. 1289.



Enlargement of prostate towards rectum.

(2) I will next proceed to consider the changes brought about in the prostatic urethra by hypertrophy of the gland, as far as they relate to the obstruction of micturition. As already stated, enlargement of the prostate towards the rectum may take place without altering the relations of the canal passing through it. Hence there is no interference with micturition, nor obstacle to the introduction of the catheter into the bladder; this is shown in the

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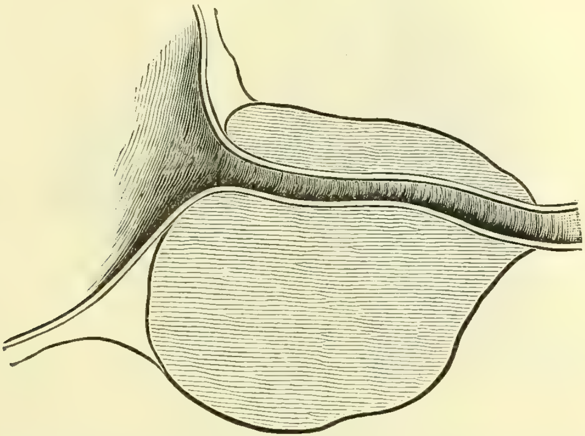
[1] Med.-Chir. Trans., vol. xliii.

annexed sketches. Fig. 1288 represents a section of the normal prostate. In Fig. 1289, though there is enlargement towards the rectum, the relations of the prostatic urethra are unaltered. In Fig. 1290 there is considerable enlargement of the gland toward the bowel, but the line and dimensions of the urethra are thereby but little altered.

Fig. 1290.



Considerable enlargement of prostate towards rectum with straightening of prostatic urethra.

Hypertrophy may, however, considerably disturb and disarrange the prostatic urethra. Most frequently this is effected by the upward growth of that portion of the gland which, since the days of Sir Everard Home, has received the name of the third lobe ; and it is astonishing how complete an occlusion of the internal urethral meatus may be effected by even a slight elevation of this portion of the gland, provided that it is central. From the annexed illustrations, taken from specimens which I have examined, it will be seen that in this form of hypertrophy the prostatic urethra is curved upward, and that a distinct obstacle to micturition, or to the passage of an instrument into the bladder, is thus somewhat abruptly thrown up. It will be noticed that though there is considerable enlargement of the gland, examination by the

Fig. 1291.

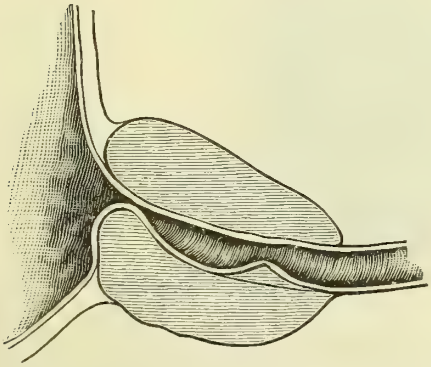
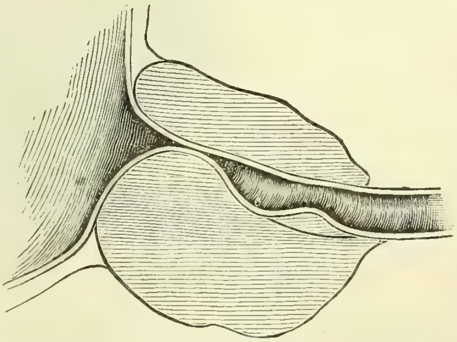


Fig. 1292.

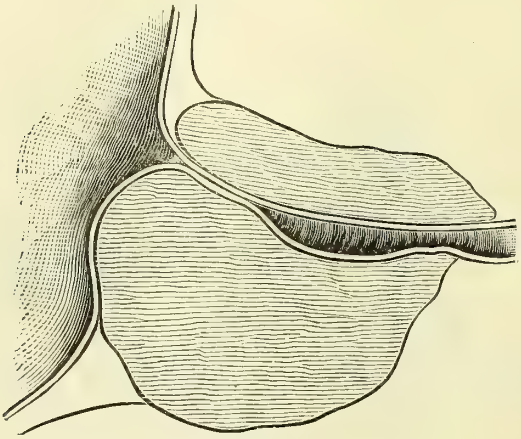


Enlargement of third lobe of prostate In the cases from which these cuts are taken, little was to be felt from the rectum.

rectum does not necessarily afford evidence of the fact, in this respect contrasting with the cases illustrated by Figs. 1289 and 1290.

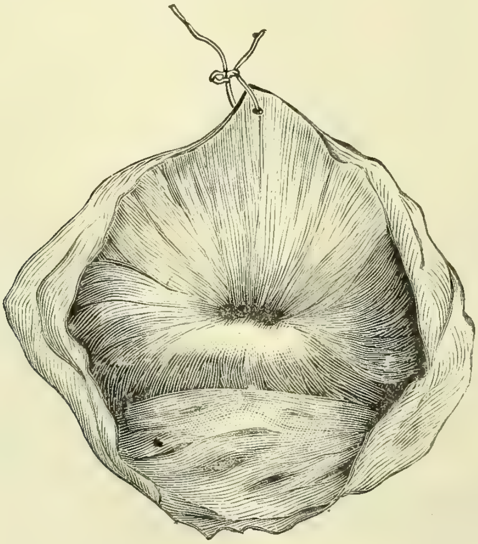
When the hypertrophy is more or less limited to one or other of the lateral lobes, the line of the prostatic urethra is deflected somewhat to the opposite side, a point which is to be remembered in the introduction of catheters. Though, as a rule, this form of hypertrophy is attended with difficulty in micturition to whichever side the urethra is deflected; yet complete obstruction seldom occurs, unless in addition to lateral hypertrophy there is a corresponding increase in the third lobe. I believe that in these lateral forms of hypertrophy a gum-elastic catheter without a stylet will be found the easiest to introduce.

Fig. 1293.



Enlargement of third lobe of prostate.

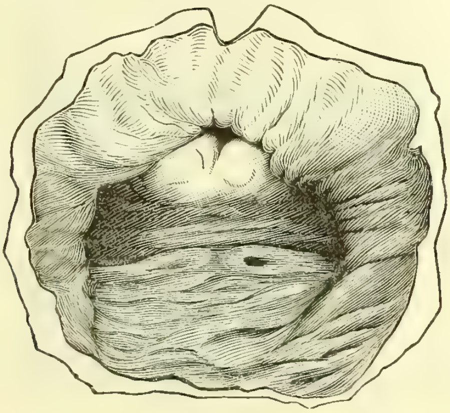
Fig. 1294.



Normal position of internal urinary meatus.

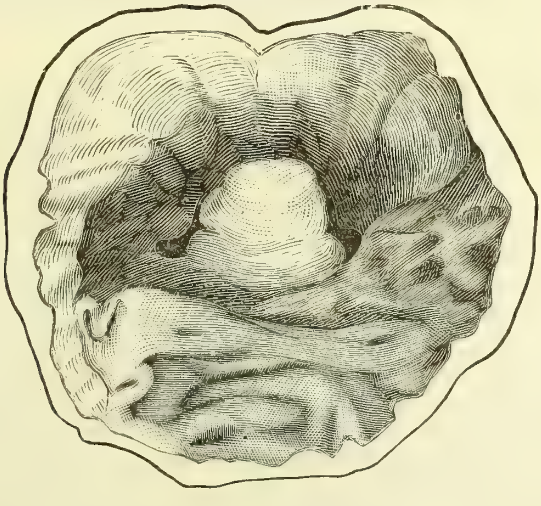
In the last place I will mention certain changes which take place in the position of the prostatic opening into the bladder. These can be best studied by examining the aperture from the vesical aspect, as was done with the specimens which the following illustrations represent.[1] Fig. 1294 represents the position of the normal internal meatus; Fig. 1295, the position of the opening in the ordinary form of enlargement of the third lobe, where the prostatic urethra forms an inclined plane ascending backwards. Fig. 1296 represents a pedunculated condition of the hypertrophied third lobe, where the urethra opens on either side of its base. This is analogous to the channels left for the passage of the urine in the lobulated form of enlargement.

Fig. 1295.



Internal meatus in ordinary form of enlargement of third lobe of prostate.

Fig. 1296.



Pedunculated hypertrophy of third lobe of prostate; urethra opening on either side.

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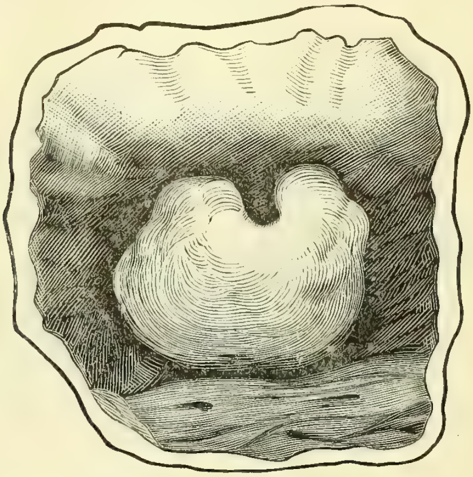
[1] I am indebted to my colleague, Mr. Mitchell Banks, for these drawings, which are taken from specimens in my collection, and from rough sketches of my own.

In such a case, on side section, the urethra would still be found almost horizontal, as in the normal state. Fig. 1297 represents a bisected condition of the hypertrophied third lobe, which was probably the result of constant catheterization.[1] The line of the urethra, as in the preceding specimen, still remains nearly horizontal. In the cases from which Figs. 1296 and 1297 are taken, micturition was not interfered with, by reason of the direction and relation of the prostatic urethra being practically unaltered. It will be presently urged that the conditions which existed in these cases are capable of artificial production to a useful extent.

Fig. 1297.



Bifid hypertrophy of third lobe of prostate.

Treatment.—Before proceeding to consider the treatment of prostatic hypertrophy, the question naturally arises as to whether anything can be done to prevent its occurrence. As the cause of the affection has not yet been thoroughly determined, it is hardly necessary to say that there are no known means for preventing it, and it is useless, therefore, to discuss a series of surmises which have already occupied sufficient attention. If, as there is some reason to infer, this change is related to the natural function of the organ, or is a result of its excessive employment, I am afraid that, although we might have the satisfaction of possessing an explanation of its origin, we should still experience no little difficulty in preventing its occurrence.

The treatment of enlargement of the prostate will be considered with reference to the only symptom which, as a rule, leads to its recognition, namely, interference with micturition; for as long as this act continues to be painlessly and efficiently performed, no one is at all likely to complain of it.

As already noted, the earliest symptoms of enlarged prostate usually relate to some gradually increasing difficulty in urination; either the stream is diminished in volume, or in extent of propulsion, or the act is too frequently performed. These indications point to a physical obstruction, which examination shows to be seated in the prostate. Occasionally under these circumstances, with little or no warning, and probably owing to some accidental circumstance, such as exposure to cold or an over-indulgence in wine, the expelling power of the bladder, long perhaps carried on with difficulty, suddenly breaks down, and retention of urine occurs. In this way a very large prostate is sometimes discovered. In both of these ways of manifesting itself, prostatic hypertrophy resembles urethral stricture.

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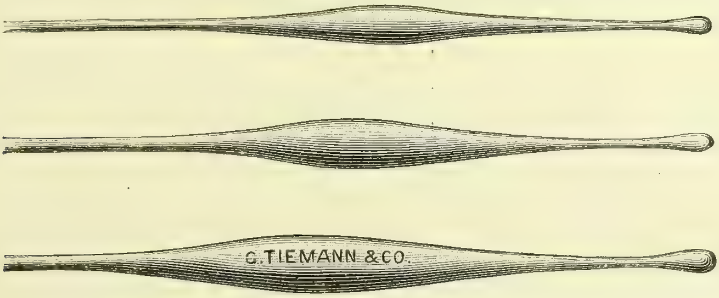
[1] Harrison, op. cit., p. 18.

On the earliest manifestations of prostatic obstruction, mechanical treatment should be resorted to with the same diligence that is required in the treatment of other forms of urethral obstruction. If this be not done, it is only postponing the day until the necessity is greater and the difficulty more apparent. It has already been pointed out that there are at least two conditions of the enlarged prostate which are unattended with obstructed micturition, where either channels are formed between the masses of the growth, or the line of the urethra remains unaltered. These conditions may, as I have already said, be artificially produced to an extent capable of being useful. For this purpose I have recently devised[1] some specially adapted bougies, which I use. They are of gum elastic, from two to four inches longer in the stem than the ordinary instruments, and have an expanded portion, an inch from the tip, which is made to enter the bladder. If dilatation be not too rapidly proceeded with, no irritation will be aroused; on the contrary, irritability will subside by reason of the completeness with which the bladder is emptied. Where there is residual urine, catheters of a similar shape may be substituted, thus allowing any water to be drawn off, whilst at the same time the prostate is subjected to dilatation.

Fig. 1298.



Prostatic dilators.

The above statements represent briefly my views with regard to the importance as well as the means of endeavoring to secure an unobstructed "water way" on the earliest signs of an increasing prostate impeding micturition. Without wishing to give them undue prominence, I feel that they cannot be passed over without some notice, inasmuch as a considerable experience and its results have justified their claim to consideration. Though the time when mechanical interference is to be systematically employed may be open to question, there can be no doubt about the necessity for it when one of two events, both frequent in the history of these cases, occurs, namely, either the bladder incompletely emptying itself, or retention of urine taking place. The former condition has reference to the formation of a pouch behind the upgrowing gland, or to the development of sacculi, in both of which urine remains in the bladder after micturition is apparently completed. The latter arises either from the occlusion of the orifice of the urethra by the prostate, or from incapacity of the bladder to supply the necessary expelling power. Both conditions require mechanical relief.

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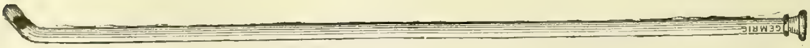
[1] Op. cit., p. 21.

Where there is residual urine, the fact is indicated by signs of its decomposition. It smells offensive or ammoniacal, becomes alkaline, and contains mucus in excess. Its presence is proved by obtaining urine with a catheter after the patient thinks that he has emptied his bladder. A persistence of this condition of residual urine invariably ends in the production of chronic cystitis, the management of which has already been described.

When the patient is thus prevented from completely emptying his bladder, artificial assistance must be rendered. Sometimes an altered position, such as bending forwards on the knees, is found sufficient for supplementing micturition. This may be tried, but as a rule the patient finds greater comfort and convenience from the use of a well-devised catheter, which he is instructed how to introduce. The flexible-rubber instrument should first be tried. Failing these, a gum-elastic catheter. With one or other of these instruments the patient should be required to draw off his water just as often as he feels a necessity for this relief. A person of ordinary intelligence will soon find this out for himself. It would be just as absurd to prescribe, under these circumstances, how frequently the catheter should be passed, as it would be to indicate how many times in the twenty-four hours a patient should make water. It is astonishing to notice how rapidly the urine often returns to its normal state, and what comfort the patient, who may have been suffering from extreme irritability of the bladder, will derive from this treatment alone.

Where sudden retention of urine occurs in elderly persons, the cause of it will be at once suspected, when, on introducing a catheter, the position of the obstruction coincides with that of the prostate. To overcome this obstacle and reach the bladder, it will generally be found that some modification in the form of the instrument is necessary. As a rule, a moderate-sized, gum-elastic catheter, three or four inches longer than that required for retention arising from obstruction in other parts of the urethra, should be selected. Reference is made to the length of the instrument, as surgeons have often failed to relieve retention in prostatic cases, not from making false passages, but from the catheter being too short. It must be remembered that a large prostate may add very considerably to the length of urethra to be traversed before urine flows. Some prefer Mercier's elbowed catheter (Fig. 1299), in which the end of the instrument is bent at a suitable angle. When the prostate is reached, assistance may often be rendered by the finger in the rectum lifting the end of the instrument over the obstruction; or, again, the expedient of passing down a stiff stylet, bent at an angle, along the catheter, is often successful in causing the point to surmount the enlarged lobe, and so to enter the bladder.

Fig. 1299.



Mercier's *sonde coudée*, or elbowed catheter.

The extent to which the bladder may be distended in cases of enlarged prostate, is often very remarkable. Several quarts of urine have been removed at a sitting, and the question as to whether the case was one of ascites or bladder-distension, has arisen. There is a specimen in the Museum of the Liverpool Royal Infirmary, of a large prostate with an enormously distended bladder, which had been tapped, as for ascites. It is stated in the catalogue that twelve quarts of fluid, which turned out to be urine, were removed. It is also added that the withdrawal of the fluid was followed by hemorrhage into the bladder, which probably contributed towards a fatal result. In cases of largely distended bladder, in enfeebled persons suffering from prostatic enlargement, it is a point for consideration whether the whole of the urine should be removed at once. Where the distension is great—for instance, when the collection amounts to several pints—it is better not to empty the bladder suddenly. The objections to the removal of a large quantity of urine at once, are these: in an enfeebled person it is apt to be followed by syncope, or, when the pressure is thus suddenly removed from the bloodvessels of the parts, by passive hemorrhage into the bladder. Such a loss of blood has proved fatal in a few days. These effects are similarly observed after the rapid removal of fluid from other parts of the body. Syncope, after tapping for ascites, is not uncommon, and cases have been observed in which the withdrawal of the ascitic fluid has been immediately followed by fatal hæmatemesis. Further, the bladder is more likely to regain its muscular power when it is gradually emptied, than when it is suddenly reduced to a flaccid condition. Hence it is a good rule, in the case of a feeble person who, for some days, has been suffering from retention, and whose bladder is considerably distended, to draw off the urine by degrees.

The size and direction of the prostatic enlargement sometimes render the introduction of the catheter impossible, and then the question arises as to what had best be done. Forced catheterization—by which is meant driving the instrument through the obstruction, and thus entering the bladder—has been advocated, but is a proceeding not to be recommended. Tapping the bladder, which will be referred to hereafter, is the proper remedy under these circumstances.

In cases of difficult and frequently needed catheterization arising from an enlarged prostate, it is the practice of some to retain an instrument in the bladder by tying it in, or by some other contrivance rendering it self-retaining. As a rule, this is not desirable, retained instruments often proving great sources of annoyance to the patient. If, from the extreme irritability of the bladder, it seems desirable to try this plan, it is best effected by securing the instrument with tapes, and then affixing a piece of rubber-tubing to the end, sufficiently long to permit the urine to be conveyed, as it is secreted, into a receptacle by the patient's bedside. The plan of bladder-drainage advocated by Mr. Chiene, to which reference has already been made, will be found most comfortable, as well as effectual. The annoyance produced by a retained catheter can be reduced to a minimum by the observance of scrupulous care in washing out the bladder, and in removing all extraneous sources of irritation. As a rule, but little advantage will be found in these cases from the various forms of self-retaining instruments, such as winged catheters and the like.

Incontinence of urine is a phrase often made use of in connection with the set of symptoms to which an enlarged prostate gives rise. We understand by it, that the bladder is full—so full that it is actually overflowing; it is another indication for the use of the catheter.

In connection with this subject it may be mentioned that prostatic enlargement may, by inducing certain changes in the urine, lead to the formation of a calculus, the symptoms of which are masked by those of the original disorder. Further, the hypertrophied gland, by concealing the stone behind it, may prevent the ready detection of the latter by the sound. It is a good rule in all these cases, when the opportunity occurs, to examine the bladder for stone, and not forget to explore, by reversing the searcher, the depression which so frequently exists behind the enlargement.

I will now pass on to notice the treatment of those extreme conditions of prostatic hypertrophy in which the enlargement and cystitis combined render the patient's life most miserable, and in which he lives, in fact, with little other occupation than endeavoring to pass water, or introducing a catheter. This consists in the establishment of a channel other than the urethra, through which the urine can be more easily voided.

Sir Henry Thompson,[1] a few years since, advocated in these cases puncture above, or rather behind the pubis, the proceeding resembling somewhat the high operation for stone. A permanent opening has thus been established with good results, patients living comfortably, and passing all their urine in this way, for considerable periods of time. [The same surgeon has more recently recommended that an opening should be made in the membranous portion of the urethra, and that a tube should be thus introduced from the perineum.]

In a case of large prostate, where catheterism was attended with considerable difficulty, I tapped the bladder from the perineum through the gland,[2] the canula being retained with the greatest relief to the patient for a period of over three months, when he was able to dispense with it. This case will be again referred to.

For establishing a permanent opening in cases of advanced prostatic obstruction, puncture by the rectum is not to be recommended. It is not adapted for anything but very temporary purposes.

Notice of the various operative proceedings which have been practised for the relief of prostatic obstruction cannot be concluded without a reference to certain proposals which have for their object the section or excision of the obstructing part. This proceeding, advocated and practised by Mercier, has recently received some support from Gouley, in America, and from Teevan, in England. It consists essentially in the division or resection of the obstructing prostate by means of what amounts practically to a concealed bistoury. I do not think that this operation is likely ever to occupy a prominent position in this department of surgery. The risk of hemorrhage, and the difficulty of dealing with it, should it occur, will prevent its performance except under very unusual circumstances. [Amussat divides the obstructing portion of the prostate with the galvanic cautery.]

Lateral cystotomy has also been performed to relieve the distress to which an enlarged prostate may give rise. Mr. Lund, of Manchester,[3] has recorded a case in illustration of this practice, which, under similar circumstances, would be quite worthy of imitation.

There are certain points which should be borne in mind in advising patients who have enlarging prostates and probably weakened bladders, or rather bladders whose power is readily extinguishable; these instructions may be briefly summed up as follows:—

(1) To avoid being placed in circumstances where the bladder cannot be emptied at will.

(2) To avoid checking perspiration by exposure to cold, and thus throwing additional work on the kidneys. In a variable climate, elderly persons should, both in winter and summer, wear flannel next to the skin.

(3) To be sparing in the use of wines or spirits which exercise a marked diuretic effect, either by their quantity or by their quality. Those should be selected which promote digestion, without palpably affecting the urinary organs. A glass of hot gin-and-water, or a potent dose of sweet spirit of nitre, will not do anything towards removing the residual urine behind an enlarged prostate.

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[1] Op. cit., p. 287.

[2] British Medical Journal, December 24, 1881, and April 8, 1882.

[3] Transactions of International Medical Congress. London, 1881.

(4) To be tolerably regular in the quantity of fluids daily consumed. As we grow older, our urinary organs become less capable of adapting themselves to extreme variations in excretion. Therefore it is desirable to keep to that average daily consumption of fluids which experience shows to be sufficient and necessary. How often has some festive occasion, when the average quantity of fluid daily consumed has been greatly exceeded, led to the over-distension of a bladder long hovering between competency and incompetency. The retention thus caused, by suspending the power of the bladder, has been the first direct step in establishing a permanent, if not a fatal, condition of atony or paralysis of the organ.

(5) It is important that from time to time the reaction of the urine should be noted. When it becomes permanently alkaline, or is offensive to the smell, both necessity and comfort indicate the regular use of the catheter. If practicable, the patient should be instructed in the use of this instrument

(6) Some regularity in the times of passing water should be inculcated. We recognize the importance of periodicity in securing a regular and healthy action of the bowels, and though the conditions are not precisely analogous, yet a corresponding advantage will be derived from carrying out the same principle with regard to micturition.

The sum of these instructions is, that, as we cannot arrest the degenerative changes by which the prostate becomes an obstacle to micturition, it is of the first importance that every means should be taken to compensate for this by promoting the muscularity of the bladder, and by thus preventing its being atrophied or paralyzed either by accident or improper usage.

Lastly, as to the power of medicines in controlling enlargement of the prostate, there is but little to be said. Ergot and ergotine, administered by the mouth or subcutaneously, have been vaunted as possessing the power, not only of preventing further enlargement of the gland, but of actually diminishing its size. Dr. Atlee[1] found considerable advantage from the use of ergot in these cases, and his experience has been to some extent corroborated by that of other practitioners. My observation is favorable to the use of the drug in cases of difficult micturition in connection with large prostate, but I believe that the gain comes from the stimulating effect of the ergot upon the muscular coat of the bladder, rather than from any diminution which it causes in the size of the obstructing gland. In a communication[2] relating to the enucleation of tumors of the prostate in connection with lithotomy, I drew the following conclusions: (1) That lateral cystotomy may be practised in certain cases of enlarged prostate which are attended with symptoms producing great distress, with the view of exploring and, if possible, of removing the growth. (2) That in all cases of cystotomy for calculus, where the prostate is found to be enlarged, a careful search should be made with the finger with the view of effecting the removal of the growth, should this be found practicable. (3) That in determining the selection of lithotomy or lithotrity in a case of stone in the bladder complicated with enlargement of the prostate, regard should be had to the possibility of removing both of these causes of annoyance by the same operation.

ATROPHY OF THE PROSTATE.

Atrophy of the prostate is a condition occasionally observed. It has been met with in middle-aged men under circumstances in which there were no grounds for suspecting that any change had taken place in the gland. Structurally it appears to consist in the wasting of the glandular element, little remaining behind but what is essentially fibrous. In two instances which I have seen, it occurred in men who, as far as was known, had never had any children, a circumstance which seems to indicate that the condition may be due either to defective development, or to changes occurring at a time of life when the opposite state—that of hypertrophy—is rarely met with. Hence it cannot be regarded as having a distinct relation to advancing age.

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[1] New Orleans Medical and Surgical Journal, August, 1878.

[2] Med.-Chir. Trans., vol. lxv. p. 43.

I have in my collection a specimen of unilateral atrophy of the prostate taken from the body of a man sixty years of age: it is associated with an absence of the ureter on the same side, and with a rudimentary condition of the corresponding seminal vesicle. Nothing further is known of the person from whose body this specimen was removed.

The removal of the gland, either entirely or in part, by abscesses, prostatic calculi, tubercular deposits, and other conditions implying general waste, in which the prostate seems to share in a degree more than proportionate to its size, can hardly be regarded as illustrations of atrophy in the sense now being considered. Still, it must be remembered that it may be brought about in these ways.

As far as treatment is concerned, there are no special indications to which reference should be made. Assuming that the cause of sterility on the part of a male is probably traceable to an arrested development of the prostate as detected by rectal examination, it need hardly be added that the imperfection is one for which no treatment can be of any avail.

Atrophy of the normal prostate has occasionally followed its incision, as in the operation of lithotomy; whether this is due to the destruction of the ejaculatory ducts, as a consequence arising out of the methods employed for the removal of the stone, or to their becoming involved in the cicatrix, are points which cannot at present be regarded as determined. Reference has already been made to a case in which atrophy of the enlarged prostate followed its puncture by a trocar and canula, and the retention in the bladder of the latter for three months. These circumstances will be again referred to in connection with the subject of tapping the bladder.

Though there is little to be said respecting the symptoms or treatment of this condition, its pathological importance is not to be undervalued, on account of the light which its study may possibly throw upon the causation, prevention, and management of the commoner and more important affection—hypertrophy.

Tumors and Cancer of the Prostate.

Like other portions of the genito-urinary apparatus, the prostate is liable to be the seat of tumors which may be classified as innocent or malignant. The former constitute the more frequent variety, and consist of a structure more or less identical with that of the normal gland. Ordinary hypertrophy of the prostate has already been considered, but it is further necessary to point out the existence of certain growths analogous to hypertrophy, which may be regarded as coming more strictly under the denomination of tumors, rather in regard to certain peculiarities in arrangement than to structure.

Fibromas, prostatic tumors, or adenomas as they are variously called, have recently had prominence given to them from their removal having been effected either by accident or design during the performance of lithotomy. Under these circumstances, or in the post-mortem room, they have been met with either (1) as isolated tumors imbedded in the gland and readily separable from it, or (2) as growths continuous with the gland, of which condition the pedunculated and enlarged third lobe is an illustration. In the symptoms to which these growths give rise there is nothing to distinguish them from ordinary prostatic hypertrophy, nor can their treatment be regarded as different.

When met with in the course of the operation of lithotomy, they have been variously dealt with. In a communication on this subject,[1] I have narrated two cases of the kind in which isolated tumors were successfully removed by enucleation with the fingers. In neither of these cases did the proceeding entail any serious consequences, the patients being relieved not only of their calculi but also of their prostatic tumors, which were sufficiently large to occasion inconvenience. Similar cases have been recorded by the late Sir William Ferguson,[2] Mr. Cadge,[3] and others. When the tumor is under these circumstances found to be continuous with the prostate gland, as, for instance, when the third lobe is enlarged and pendulous, it may be removed by avulsion with the finger; occasionally it has been brought away accidentally between the blades of the lithotomy forceps, without any ill consequences resulting. I have suggested, in the communication already referred to, that when, in the course of a lithotomy or a cystotomy, any portion of the prostate is found to be pendulous, its removal by means of some simple form of *écraseur* should be undertaken, rather than that it should be left to grow and possibly obstruct micturition.

Malignant Tumors.—These are rare, either as primary growths, or as secondary deposits or extensions of tumors primarily affecting other organs, such as the bladder or penis.

Of the various forms of carcinoma affecting the prostate, the encephaloid variety is generally admitted to be the most common. Cancer of the prostate has usually been observed either in early life or after forty years of age. On the authority of Dr. Picard,[4] it is stated that, with the exception of the eye, cancer, in children, attacks the prostate more frequently than any other organ.

The precise origin of the disease is always obscure, as death does not take place until all traces of normal structure are lost. Commencing in the mucous membrane, or in the substance of the gland itself, the tumor takes the form of a circumscribed mass, which in its growth may fill, or even distend, the bladder. Nor is it confined to the limits of the capsule, for the vesiculæ seminales, the rectum, and the ureters, may all become involved. Secondary deposits are found in the neighboring glands, a point which is of considerable importance in enabling the surgeon to arrive at a diagnosis. The consistence of the growth, and its appearance, vary much, being determined by its duration and liability to hemorrhage or disintegration. In a case which I have recorded,[5] in which the disease was believed to have originated in the prostate, the bladder was completely filled with a brain-like substance, which gave prominence both to the perineal and supra-pubic regions. Before the patient's death, large sloughy masses of the growth, mixed with bloodclots, escaped freely through a perineal opening which circumstances had rendered necessary. In this case, enough encephaloid matter was expelled from the wound to fill a pint vessel. In the only case of this kind which has come under my observation for some years at the Liverpool Royal Infirmary, the Pathologist, Mr. Paul, reports that secondary deposits were found both in the glands and in the lungs, and that histologically the new growth was a large-cell spindle-celled sarcoma. The patient was 51 years of age. The following is a description of the appearances:—

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[1] Loc. cit.

[2] Lancet, vol. i. 1870.

[3] Trans. Path. Soc. Lond., vol. xiii.

[4] Traité des Maladies de la Prostate. Paris.

[5] Op. cit., p. 351.

The prostatic portion of the urethra and neck of the bladder were entirely surrounded by a soft, encephaloid new growth, which formed a round, elastic swelling as big as a medium-sized orange, between the bladder and the rectum, and which had evidently commenced in the prostate. The growth was almost in a sloughy state, and so friable that it could be squeezed through an incision as easily as the contents of a sebaceous cyst. The bladder itself was fairly healthy.

In children these growths usually advance with great rapidity, whilst in adults their progress may be slow.

Symptoms.—As the disease has been known to occur in a prostate already hypertrophied, the early symptoms may be very obscure. They are generally associated with some impediment to micturition. As a rule, the disease develops with far greater rapidity than any other form of prostatic growth. There is irritability of the bladder, and often repeated and considerable hemorrhages at the close of micturition. Rectal examination usually discloses some prostatic irregularity or outgrowth, very unlike what is met with in the innocent forms of enlargement. In addition, some glandular swelling may be detected. When the tumor assumes a considerable size, symptoms resulting from pressure on the rectum, such as a distended colon, may arise. Under these circumstances colotomy has been suggested.[1] As the disease advances, the appearance to which the term "cancerous cachexia" has been applied, becomes marked.

In the case observed in my own practice, to which I have referred, on passing a catheter for the purpose of exploring the bladder, the instrument became blocked with a brain-like substance, which could be afterwards squeezed through the urethra by pressure on the prostate from the rectum. Scirrhous carcinoma is still less frequently observed than the encephaloid variety. Of my own personal knowledge, in a district which furnishes abundant cases of every form of cancer, I am aware of only three instances. Two occurred in my own practice in the Liverpool Royal Infirmary, the post-mortem and histological examinations having been made by Mr. Rushton Parker. Though presenting a resemblance to ordinary hypertrophy of the prostate, the induration of the gland, coupled with the discovery of secondary deposits—in one instance in the liver, and in the other in the lung—left no doubt as to the nature of the disease. The third instance I have elsewhere recorded.[2]

The distinguishing feature of scirrhus of the prostate is its extreme hardness, which is generally associated with irregularity in outline, as detected by rectal examination. The early symptoms of the disease are vague, and, beyond what may be revealed by the finger, are not distinguishable from those of prostatic hypertrophy.

A case of colloid scirrhus of the prostate has recently been reported by Mr. S. Boyd.[3] The symptoms had extended over two years. The prostate was found infiltrated by a new growth, which extended back and implicated the bladder, leaving only the posterior part of that viscus unaffected; both vesiculæ seminales were filled with colloid material, and the opening of each ureter was situated at the summit of a nodule of the growth. The microscopical examination showed the growth to consist of a fibrous stroma, with numerous alveoli; the stroma was nowhere so dense as in scirrhus of the breast; there was extensive colloid degeneration.

In the *treatment* of malignant growths of the prostate, beyond relieving the symptoms of obstruction to micturition which may arise, there is nothing to be done but to palliate with anodynes, and sustain with nourishment. I am not aware that excision of the prostate has ever been practised, nor is it a proceeding to be advocated.

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[1] Lancet, June 24, 1882.

[2] Op. cit., p. 351.

[3] Trans. Path. Soc. Lond., 1882.

A case in which an attempt was made to remove a sarcomatous growth of the prostate by perineal incision, is recorded by Mr. Spanton.[1] The previous symptoms had been chiefly those of obstruction to the rectum upon which the growth pressed so as to flatten it. This occasioned distension above, and an incessant but ineffectual desire to evacuate a stool. It was found impossible to remove more of the tumor than that in contact with the rectum, as it extended behind the pubis. The proceeding was attended with considerable hemorrhage, and the patient died on the following day. An autopsy showed that the tumor so overlapped the bladder, behind and above the pubis, as to conceal it.

TUBERCLE OF THE PROSTATE.

In the course of urinary tuberculosis the prostate may become involved, but it is rare to find the disease limited to the gland. In the more advanced illustrations of the affection, the deposit is found in the kidneys, testicles, and vesiculæ seminales, as well as in the lungs. The tubercles take the form of small gray points scattered throughout the glandular tissue; these may coalesce, and ultimately form abscesses. In this way the whole of the prostate has, in some instances, been converted into a pultaceous mass of pus and tubercle, which may be discharged either through the urethra or through the rectum.

As tubercle of the prostate almost invariably exists in connection with a similar deposit in some other organ, such as the kidney or testicle, where the diagnosis can be made with greater certainty, the occurrence under such circumstances of vesical irritability which can only be referred to the neck of the bladder, must be regarded as an indication that the prostate is probably becoming involved. It is almost impossible to indicate any special symptoms which may be said to determine the existence of tubercle at an early stage. So frequently does tuberculosis of the prostate coexist when the testicle is similarly affected, that in all cases of the latter the prostate should be carefully explored by rectal examination, when distinct points where tubercular deposit has taken place, may be detected. It has been remarked by Fleming,[2] that these cases are usually referable to protracted gonorrhœa occurring in strumous subjects, in whom that disease is often very uncertain and slow in its progress.

The *treatment* of this affection resolves itself into the employment of general measures directed towards arresting the progressive development of the tubercular state. These include the administration of cod-liver oil, steel, and a nutritious diet. Tepid sea-water bathing is often of considerable service in this class of affections. Locally, anodyne applications to relieve pain and vesical irritability will be necessary.

As the symptoms sometimes simulate those of vesical calculus, the introduction of a sound into the bladder may be required for the purpose of establishing a diagnosis. As a rule, however, instrumental interference with the urethra in these cases should be avoided. Tubercular abscesses of the prostate have sometimes opened into the rectum. Should fluctuation be detected from the bowel, it would be better to puncture in this position rather than permit the matter to burrow in other directions. In cases where fluctuation is not detected by the finger in the rectum, should an abscess form, it will probably discharge spontaneously into the urethra. By urine finding its way into and being retained in the cavity of such an abscess, further inflammation and suppuration will probably be set up, and a communication may be ultimately established between the urethra and the rectum. This has on several occasions been noted as a termination of tuberculous prostatitis.

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[1] Lancet, June 24, 1882.

[2] Injuries and Diseases of the Genito-Urinary Organs. Dublin, 1877.

Cysts of the Prostate.

Cysts, varying in size from that of a millet-seed to that of a pea, are often observed when a section is made through the prostate. It seems probable that they take their origin in an obstruction of one or more of the gland ducts. The contents generally resemble viscid mucus, and minute calculous particles may sometimes be felt. As a morbid condition little is known of these cysts, nor are there reasons for believing that they ever occasion any inconvenience. There is a form of cyst which has been described by Dr. Englisch,[1] of Vienna, which appears to be due to an occlusion of the orifice of the sinus pocularis in the prostatic urethra, and an accumulation of the secretion from the glands opening on its inner surface. Such cysts, according to these observations, have not only occasioned difficulty in micturition, but have led to other changes, such as distension and hypertrophy of the bladder, with remoter effects, due to urinary back-pressure on the kidneys. As Dr. Gross[2] remarks, "a knowledge of this variety of tumor is not devoid of practical interest, since a part at least of the cases of retention of urine in the new-born child may be traced to this cause."

Prostatic Calculus.

Like other gland structures, the prostate is liable to the formation of calculous concretions which will require special consideration. In structure they are entirely different from other calculi met with in the urinary organs, and appear to consist of the natural secretion of the gland in an altered form. The relation of the minute concretions so frequently met with in almost all prostates with the rarer affection of prostatic calculus, is well described in the following passage: "The prostate gland, like other glands, is liable to an inspissation of its secretion, producing small, yellow, sometimes red, or colorless bodies, scattered throughout the follicular structure. These, at first, are said to consist of organic matter which Virchow believes to be derived from a peculiar, insoluble protein substance mixed with the semen; but sooner or later these formations are believed to irritate the mucous membrane, causing phosphatic depositions which become encrusted upon the organic matter; and thus the genuine prostatic calculi are formed."[3]

In this way prostatic calculi take their origin, their number, shape, and size varying in individual cases. It will be readily understood that the smaller formations in their chemical composition almost entirely consist of organic matter, whilst in the larger ones phosphate of lime largely predominates.

Although taking their origin in the ducts of the gland, these concretions may assume a considerable size by their aggregation. In this way the prostate has, in some rare instances, been converted into a stony mass, the fibrous capsule alone of the original structure remaining. Amongst these cases must be mentioned one recorded by Dr. Barker, of Bedford, England,[1] in which the calculus weighed three ounces and a half, and consisted of twenty-nine pieces of a whitish color, and porcelainous lustre and hardness, closely soldered together and measuring nearly five inches in length. It was removed from a man twenty-nine years of age, who had suffered from incontinence of urine from his fourth year. A somewhat similar case is recorded by Mr. Benjamin Gooch, of Norwich.[2] In some cases it has been observed that the several fragments composing the mass have been dove-tailed together with most remarkable accuracy. These concretions have occasionally made their escape from the prostate, and have been voided with the urine.

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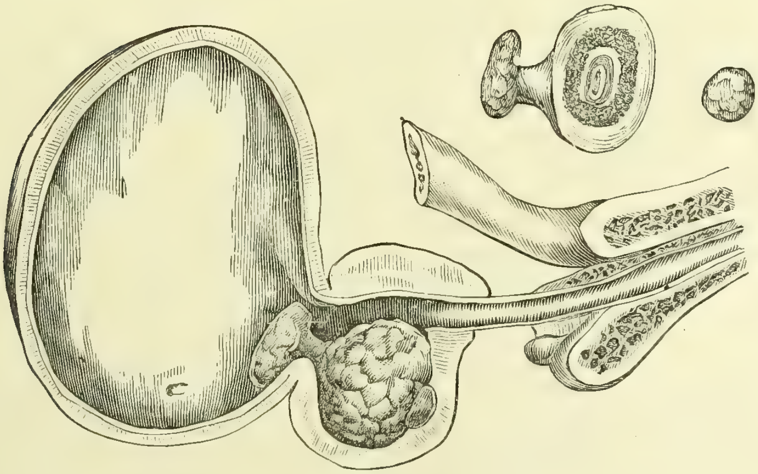
[1] Stricker's Med. Jahr. Heft i. 1873, und Heft ii. 1874.

[2] Op. cit. p. 413.

[3] Poland, Holmes's System of Surgery, vol. iv.

Symptoms.—When small, these concretions seldom occasion any inconvenience; they have been frequently found after death in large numbers when previously there had been no reason to suppose that there was anything amiss with the prostate. On the other hand, there can be no doubt that their presence serves to explain the existence of irritability and pain about the neck of the bladder, which is otherwise unaccountable. In some instances they give rise to symptoms precisely similar to those occasioned by stone in the bladder. Under these circumstances, the presence of calculi within the limits of the prostate may be determined by the use of the sound combined with digital exploration from the rectum. When existing, as they often do, in conjunction with stone in the bladder, stricture, or prostatic hypertrophy, they are often overlooked, and under almost all circumstances their recognition is attended with considerable difficulty. Digital examination of the prostate by the finger in the rectum, is a proceeding which must not be overlooked

Fig. 1300.



Poland's case of prostatic calculus.

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[1] Trans. Prov. Med. and Surg. Assoc. 1847.
[2] Cases and Practical Remarks in Surgery, p. 57.

where this condition is suspected. Gross very properly lays stress upon the circumstances that the concretion is invariably fixed; that it is only to be felt at one spot; and that it does not, like a vesical calculus, alter its position with the various movements of the body.

Treatment.—Should troublesome urinary symptoms be distinctly traceable to the pressure of a prostatic calculus, means must be taken to remove it. This can probably be best effected by a median perineal incision; in this way risk of hemorrhage will be avoided, whilst sufficient room will be afforded for the necessary manipulations with the finger or the forceps.

Some very remarkable cases have been recorded in which almost the whole of the prostate gland has been removed by the pressure of dumb-bell-shaped calculi, situated partly within the bladder and partly within the prostate. In these instances the urethra has remained pervious. This condition is well illustrated by a case recorded by Mr. Poland[1] (Fig. 1300). These calculi, however, are not in their origin of the nature of those now under consideration. Reference is made to them for the purpose of showing how, in another way, the place of the prostate may, either in part or in whole, be occupied by material very different from that composing the normal gland.

HÆMATURIA.

Hæmaturia, or the presence of blood in the urine, is a symptom which is common to many affections of the urinary system. Its appearance is generally unmistakable, and naturally creates much apprehension in the mind of the patient, even though it may be connected with some disorder which is easily remediable. Occurring as frequently as it does, it is a symptom which requires the fullest consideration, inasmuch as a careful examination of the circumstances attending its appearance, continuation, or cessation, as well as the form in which it presents itself, often throws considerable light on the precise nature of its cause. Like some other affections—for instance, irritability of the bladder—it is as a symptom that we must study it, rather than as in itself constituting a disease. It is as well to remember that not only by its presence does it often materially assist the practitioner in making a diagnosis, but its absence is frequently a determining feature in a doubtful case. As hæmaturia is capable of being produced by a variety of circumstances acting from the kidneys downwards, it will be necessary to analyze carefully the several conditions under which it presents itself to our notice.

Blood is met with in the urine, either uniformly tinging it, or in clots. When intimately mixed, it produces various shades of discoloration of the fluid, sufficient in extreme cases to produce what is known as *smoky urine*, an appearance which is often referred to as being characteristic. When the amount of blood is small, it may only be detected by the microscope, a means of investigation which should never be omitted. Albumen has sometimes been found in the urine and attributed to some renal disorder, when its presence has been really due to blood proceeding from another source, and undetected by the test-tube.

In normal urine the blood-corpuscles are visible, and retain their shape, for several days; when the specific gravity is low, or the urine ammoniacal, they rapidly disappear. "The marks by which blood-corpuscles are distinguished from other cells found in the urine, are, the extreme tenuity of their outline, the absence of visible cell-contents and especially of a nucleus, and their feeble refractive power. When the bi-concave form is preserved, this of course is diagnostic."[1]

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[1] Guy's Hosp. Reports. 1857.

Hæmaturia must not be confounded with another condition, to which the term hæmatinuria (more correctly hæmoglobinuria) has been applied. In the latter, the urine becomes highly discolored with hæmoglobin, but no blood-corpuscles are to be detected. "It is caused by rapid destruction of the blood-disks in the bloodvessels, such as occurs in that state which is known as a 'dissolved state of the blood,' in septic, pyæmic, and putrid fevers, and in some extreme cases of scurvy and purpura. In such cases hæmatine is set free by the disintegration of the red disks, and appears in the urine. Vogel found that inhalation of arseniuretted hydrogen produced an intense (but temporary) degree of hæmatinuria."[2] A careful examination of the urine with the microscope, immediately after it has been passed, will enable the practitioner not only to detect blood, should it be present in any form in the excretion, but to distinguish any coloration which may exist from that caused by hæmoglobin.

In connection with these remarks on the importance of the use of the microscope for detecting blood in the urine, reference may be made to an exceptional case of recurring hæmaturia recorded by Dr. W. Roberts,[3] in which chains of micrococci were in this way discovered immediately after the urine had been passed. Dr. Roberts concludes his observations by suggesting that this case may furnish a key to others of a similar kind in which the cause for the hemorrhage seems inexplicable.

Other means for the detection of blood in urine are the guaiacum test of Dr. John Day, of Geelong, and the spectroscopic examination of the fluid.

The former depends on the hæmoglobin of the blood setting free ozone, which colors the precipitated resin of guaiacum, a bright sapphire blue. Place a drop or two of the suspected urine in a small test-tube, add a drop of recently prepared tincture of guaiacum and a few drops of ozonic ether, agitate, and allow the ether to collect at the top. If blood be present, the ether acquires a blue color, leaving the urine below colorless. No saliva must be mixed with the urine, and the patient must not be taking a salt of iodine. The presence of much pus or mucus will cause the development of the reaction, even if blood be absent.

For the spectroscope, the urine, if turbid, should be filtered, and if very dark should be diluted until of a faint red color, when, being placed in a test-tube, and the light passing through it being examined by means of an ordinary spectroscope, it will be seen that the blue end of the spectrum is darkened. Two absorption-bands are visible just below Fräuenhofer's line D, in the yellow half of the green. The band nearer the violet end is about twice as broad as the other. If any doubt be entertained as to the position or appearance of the bands, add to the fluid a very little ammonia, then a small quantity of the double tartrate of sodium and potassium, and finally a small fragment of ferrous ammonium-sulphate. Stir the solution, close the tube, and examine with a spectroscope; when, in place of the two bands, a single fainter but broader band, intermediate in position between the two which it has replaced, will be found.

In dealing with small quantities, the micro-spectroscope may be used with advantage.

With respect both to the guaiacum and spectroscopic tests, it is to be remembered that they only show the presence of the coloring matter of the blood, and not of the blood-corpuscles, and that consequently they do not serve to distinguish between hæmaturia and hæmoglobinuria.

The other form in which blood is found in the urine is where it is clotted and not uniformly mixed with the fluid.

Clots in urine should always be carefully examined, as they may indicate by their form from whence the escape of blood is taking place. In reference to the importance of this, Mr. Hilton remarks:[1] "Swim out in water all clots whose origin is doubtful, in order that you may see the shape. Over and over again you will find yourself able to diagnose the case by this simple, common-sense expedient." Blood which has been clotted in the ureters is sometimes seen in the form of worm-like casts of those tubes.

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[1] Roberts, Urinary and Renal Diseases.

[2] Ibid.

[3] British Medical Journal, October 15, 1881.

I will now proceed to consider, in their order from the kidneys downwards, the various circumstances which give rise to hæmaturia, and any special indications, as bearing upon diagnosis, which an examination of the urine may furnish. As already observed, there is no symptom connected with the diseases of the urinary organs, which, in its thorough investigation by all the means at our disposal, is more likely to furnish a clue to diagnosis than that now under consideration.

Kidney.—Hemorrhage from the kidney may proceed either from the secreting portion of the gland, from the pelvis, or from the ureter. It may be caused by a variety of circumstances, including injuries of all kinds applied to the back or loins, the presence of calculi, the deposition of tubercle or cancer, and still more rarely parasitic affections, as in the endemic hæmaturia met with at the Cape of Good Hope, in Egypt, and elsewhere. Further, hæmaturia of renal origin is frequently met with as a symptom of other diseases which do not come within the scope of a surgical treatise. Amongst these may be mentioned Bright's disease, certain eruptive fevers, scurvy, purpura, and other causes of renal congestion. Where the hemorrhage proceeds from the secreting portion of the gland, it is generally found uniformly mixed with the urine, giving it a smoky appearance. When in addition blood-casts are discovered by the microscope, a diagnostic symptom of great value in indicating the precise nature of the lesion is afforded. Blood-casts in the urine have been frequently found following injuries to the back, where there were reasons for believing that the kidney had been ruptured. In wounds of the kidney hæmaturia is generally found to be a constant symptom. In ten cases described by Dr. Gustav Simon,[2] it invariably occurred, and in several in very considerable quantities.

A hæmaturia for which the kidney is responsible may sometimes be traceable to the existence of a stricture of the urethra. I have seen it occur under these circumstances, and completely disappear on the removal of the urethral obstruction. I need hardly remark that in this category I do not include those cases of hæmaturia which are due to the escape of blood from the urethra as a consequence of either congestion or ulceration behind the stricture, or of the use of instruments. The cases to which I here refer are, I believe, the result of back pressure on the kidney, and are remediable by mechanical treatment.

Persons who are liable to attacks of oxaluria, sometimes suffer from slight hæmaturia due to the mechanical action of the crystals in their passage along the renal tubules. In this way, as Vandyke Carter[3] has pointed out, a nucleus is furnished for the formation of a mulberry calculus by the concurrence in the kidney of a colloid and crystals. Many cases of persistent renal hæmaturia have been explained and remedied through the discovery of these crystals in the urine.

Bladder.—Hemorrhage from the bladder is frequently found attending the presence of calculi and various vesical growths; of the latter, the villous tumor or papilloma is probably the most frequent. Where blood proceeds from such a tumor, it is generally discharged in large quantities, more or less clotted, and

[1] Guy's Hospital Reports, 1868.

[2] Die Chirurgie der Nieren. 1876.

[3] Op. cit., p. 39.

often in a pure stream at the conclusion of micturition. Hemorrhage, when it proceeds from the bladder, is almost invariably attended with considerable irritability as far as micturition is concerned, a circumstance which is tolerably sure to lead to an exploration for stone being made. Such an exploration, when made carefully and at the same time thoroughly, is justifiable as often furnishing not only negative evidence, but positive information as to the cause on which the hemorrhage depends. It is hardly necessary to add that a single exploration ought to suffice, for, however valuable the information which the sound is capable of affording, it is not invariably obtained without some cost. Hence this examination should not be too hastily made, and every precaution should be taken to prevent any ill consequences arising therefrom. When a patient is suffering from hæmaturia, the result of a villous growth, an ulcerating tumor, or a tubercular deposit, not only can the absence of a stone be ascertained, but often the growth, or a ragged surface, can be distinctly felt. When a villous growth has been the cause, a portion has sometimes been brought away in the eye of the catheter used for the purpose of sounding, or has been subsequently passed with the urine.

Where hemorrhage is due to any of the causes last mentioned, the examination is almost invariably followed by a considerable increase in the quantity of blood discharged; for this, both patient and practitioner should alike be prepared, and every care should be taken, by rest and the application of cold to the region of the bladder, to moderate the hemorrhage.

Direct exploration of the bladder with the finger has been practised in cases in which there have been reasons for believing that the hemorrhage has proceeded from some undiscovered, abnormal condition of the viscus. In the female, this can be readily done by rapid dilatation of the urethra. In the male, such an exploration may be made by opening the membranous urethra in the median line. In the normal condition of the parts the interior of the bladder can in this way be reached, and the examination may be aided by bimanual manipulation, as practised by Volkmann. Sir Henry Thompson[1] has recently reported some cases illustrative of this method of examination, where hæmaturia, having probably a vesical origin, was a prominent symptom.

Vesical hemorrhage is sometimes met with in cases of enlarged prostate where there has been very great distension. If, in such a case, the whole of the urine be at once drawn off and pressure suddenly removed, passive hemorrhage is apt to occur. In this way the bladder may become filled with clot, which not only causes great distress to the patient, but is exceedingly difficult to remove. To guard against this it is better to withdraw the urine gradually, and thus permit the distended organ somewhat to recover its tone before rendering it flaccid.

Urethra.—Hemorrhage from the urethra is most frequently due to an acute gonorrhœa. It has been known to follow the forcible straightening of the penis of a person suffering from chordee. In young male children, it has been occasioned by the impaction of a calculus in the canal. Ulceration within the meatus of the urethra, most commonly of a syphilitic nature, may also give rise to this symptom. When hæmaturia has its source in the urethra, not only does the blood escape as an independent flow during micturition, but also at intervals apart from that act. In connection with the subject of hæmaturia, it should be remarked that its association with injuries of the pelvis or of the perineum should lead to a most careful investigation with the catheter of the bladder and urethra. Fractured pelvis and ruptured urethra may both give rise to this symptom. If the cause of the hæmaturia be not at once referred to its proper source, and means taken to prevent extravasation of urine, the most serious, if not fatal, results may ensue.

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[1] On Digital Exploration of the Bladder through Incision of the Urethra from the Perineum. Lancet, May 6, 1882; On Tumors of the Bladder, etc. London, 1884.

In connection with injuries to the kidneys giving rise to hæmaturia, the question may suggest itself whether the whole of the albumen contained in the urine under such circumstances is thus accounted for.

Such a case came under my notice in conjunction with my colleague, Mr. Mitchell Banks. Here the patient, after an injury to the back, was subject at varying intervals to attacks of hæmaturia. After an interval of some months it was observed that, though evidences of blood in the urine were seldom wanting on microscopic examination, yet the quantity of albumen, as compared with red blood-corpuscles, was so great, except at the times when a paroxysm of hemorrhage was taking place, as to lead to the inference that structural changes, such as are observed in certain forms of Bright's disease, had also been brought about.

The relative quantities of the constituents of the blood, as far as they can be determined by actual examination, is a point of some importance in the investigation of certain cases of hæmaturia.

Some curious forms of vicarious hæmaturia have been described. Roberts[1] mentions a case in which it alternated with epistaxis and intracranial hemorrhage. There are other instances in which hæmaturia has supplemented a hemorrhoidal flux, and other examples are recorded in which the menstrual flow has been diverted to the urinary organs, and has taken the form of a periodical hæmaturia. Lastly, it must be remembered that there are certain drugs, such as cantharides and some of the terebinthinates, which by provoking congestion of the kidneys are capable of occasioning hæmaturia.

Treatment.—The treatment of hæmaturia can only be here referred to in general terms, as it is a symptom rather than a disease. I shall therefore not do more than endeavor to indicate the principles which experience has shown to be serviceable in restraining it.

When blood proceeds from the *kidney*, the means employed to arrest it are local and general. In the congestive forms of hæmaturia, dry cupping over the loins is often of value, whilst after injuries, and in passive congestion, much reliance may be placed in the application of cold in the form of ice-bags or bladders over the part. Of the internal hæmostatics, mention should be made of the acetate of lead, alum, ergot of rye, turpentine, and matico. Acetate of lead, in combination with opium, was a favorite remedy of the late Dr. Golding Bird. Rest in the recumbent position will of course be enjoined. Where the hemorrhage from the kidney has been probably of a passive nature, I have more than once seen immediate benefit follow the placing of the patient in a horizontal position, but more or less lying on the belly. Some of the hemorrhages connected with the kidney are undoubtedly the result of hæmostatic pressure, and may be favorably influenced by position. In prescribing a diet for a patient suffering from this form of bleeding, I have often found alum-whey, administered *ad libitum*, both pleasant and serviceable.

Hemorrhages from the *bladder* are associated with causes which may or may not admit of removal. When due to the presence of a stone, its removal is an obvious expedient. When due to tumors or ulceration, such a course is less obvious, though the cause may have been determined by digital exploration of the viscus, as already referred to. More precise means of diagnosis would, no doubt, bring many more of these conditions within the grasp of surgery. The most hemorrhagic tumor of the bladder—I refer to the papilloma or villous growth—is probably fatal only by reason of the bleeding which it occasions, and not through any other character of malignancy. When hemorrhage from the bladder proceeds from causes beyond the reach of operative surgery, reliance must chiefly be placed on the styptics already mentioned. Cold externally, in the form of ice-bags, is often of service. I have sometimes found, in hemorrhage proceeding from malignant and tubercular ulceration, great benefit from irrigating the bladder with hot water—water at a temperature of 105° Fahr., gradually raised to 120°. The value of hot water in blanching tissues, and thus restraining the hemorrhage, is not sufficiently recognized in this class of affections. When employed with a suitable apparatus, and a gentle hand, it is capable of affording much relief, not only by arresting this symptom, but by controlling the cystitis which so frequently accompanies it. Reference has already been made to the best method of dealing with blood clotted in the bladder, when it occasions symptoms demanding its removal.

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[1] Op. cit., p. 135.

Hemorrhage from the *urethra*, when constituting hæmaturia, hardly requires any special reference, as it is as a rule easily detected, and readily remedied by some modification in the treatment appropriate to the condition which gives rise to it. The injection of a little iced water up the urethra, and the suspension of other local treatment, are in the great majority of instances quite sufficient to cause the hemorrhage to cease. When it occurs in gonorrhœa, it is, as a rule, traceable to the extreme anxiety evinced by the patient to get rid of this affection by the too frequent use of an injection.

Retention and Incontinence of Urine; Paralysis and Atony; Spasm and Neuralgia of the Bladder.

Retention and incontinence are conditions which may coexist and be dependent upon one cause. A patient, for reasons presently to be mentioned, may be physically incapable of expelling the urine which has collected in his bladder; eventually an overflow takes place, and thus incontinence becomes substituted for the previous inability to micturate. Hence incontinence, or the dribbling away of urine in the adult, almost invariably means that the bladder is so full that it is actually overflowing. In the child, incontinence may have a very different signification.

Retention of urine is, as a rule, readily recognized. It is often the termination of gradually increasing difficulty in micturition, and is at once obvious both to the patient and the practitioner. In other instances it is less apparent, especially in the case of individuals who, by reason of an enlarging prostate, have long been unable completely to empty the bladder. Here it may not be discovered until incontinence or overflow actually occurs. In other cases the retention is sudden and abrupt, and appears to have been preceded by no symptoms of significance. Retention of urine may be overlooked in certain conditions in which the patient is incapable of giving expression to his sensations; hence in persons who have been suddenly rendered insensible by injuries or by disease, as in apoplexy and sometimes in the insane, retention may remain unobserved, and considerable damage may be occasioned thereby.

In addition to the sensations of the patient, coupled with the fact that urine has not been passed for a certain period of time, retention is indicated by a more or less distended condition of the bladder. This presents itself as a globular, or rather egg-shaped, tumor immediately above the pubis, sometimes extending up to the level of the umbilicus. It may be here remarked that the necessity for the use of the catheter must not be judged of by the size which the bladder has attained. If one man is so insensitive as to require relief by the catheter only when the fundus of his bladder reaches to the umbilicus, we must not infer that another needs it less, because this line has not yet, in his case, been reached. Powers of endurance in this respect are very different. The patient with a small, contracted bladder, from long-standing stricture, suffers all the horrors of retention long before the indicated limit has been reached. The amount of distension has, in some instances, been very remarkable, so as even to have suggested to the practitioner that some error in diagnosis had been made. A case is recorded by Dr. Murchison,[1] in which an abdominal enlargement in the male, believed to be a hydatid tumor of the liver, turned out to be a distended bladder, holding twenty-four pints of urine. Another case is narrated by Jaccoud,[2] in which a tumor occupying the hypogastric and umbilical regions in a young woman, was at first thought to be an ovarian cyst. Other instances are to be found in which a distended bladder has been mistaken for pregnancy. Illustrations such as these do not, as a rule, indicate that there is any real difficulty in making a diagnosis between a tumor and a distended bladder, but rather the caution which is necessary in accepting the statements of persons as to their ability to micturate, and as to the completeness of the act. Because a patient passes water, we are not, therefore, justified in assuming that he can empty his bladder.

When the retention is extreme and the prostate is not large, the distended bladder can generally be felt from the rectum; fluctuation may also be detected here by palpating above the pubis. In very corpulent persons, it may be almost impossible to determine the precise condition of the bladder, when retention is suspected, by abdominal examination; hence, in cases of doubt, the catheter should be passed.

As already observed, retention of urine may, by reason of an overflow or incontinence being induced, be prevented from doing serious mischief; it is remarkable in some cases how long such a condition may continue. Where ulceration of the bladder exists, or the urethra is dilated, or weakened, behind a stricture, the patient is exposed to the danger of a sudden rupture taking place, and of extravasation of urine occurring. In some of the cases recorded as spontaneous rupture of the bladder from retention, this accident had probably been preceded by ulceration.

Suppression of urine is not to be mistaken for retention; in the former, we have an empty bladder and no urine, by reason of the kidneys failing to excrete.

Retention of urine may be due to a variety of causes, which may be included under four headings: (1) causes indirectly connected with the urinary organs, (2) structural changes in the bladder or the presence within it of abnormal contents, (3) causes originating in the prostate, (4) urethral obstruction. These conditions will require special consideration.

(1) Amongst the causes of retention indirectly connected with the urinary apparatus, we must include injuries by which their innervation is more or less destroyed, or their muscular mechanism interfered with. Injuries to the spine or cord—such as fracture, dislocation, or concussion—are frequently followed by temporary or permanent retention of urine, due to the injury of the nerves or spinal centres by which paralysis is induced. Concussion of the spine rarely occasions more than very temporary retention, although considerable weakness of the bladder, in relation to its command over the urine, may remain for some time. Paralysis of the bladder, retention, and subse-

[1] Diseases of the Liver, p. 460.

[2] Le Progrès Medical, 15 Mai, 1875.

quent incontinence of urine, almost invariably attend fracture or dislocation in any part of the spinal column. As a rule, chronic cystitis rapidly supervenes on the retention, and phosphates are deposited in abundance, sufficient, in some cases, to form stone. Under these circumstances the disease is rarely completely recovered from; if the injury be not sufficiently high up to occasion speedy death, the future comfort of the patient will, in a great measure, depend on the care displayed in the management of his bladder-affection.

There are other changes occurring in the cerebro-spinal centres, which may ultimately cause the bladder to fail in discharging its contents. In these the process is a gradually increasing one, but the ultimate results, as far as this viscus is concerned—the rendering of the urine alkaline, the production of phosphates, and the deposition of ropy mucus in excess—are similar to those observed after injuries to the spine. Retention of urine frequently occurs in the course of fevers, such as typhus, where the functions of the nerve-centres are more or less in abeyance. Reflex irritation, as, for instance, that occasioned by the ligature of hæmorrhoids, sometimes leads to retention. It will not be necessary to further illustrate causes of retention other than those in which the urinary organs are immediately concerned. Under this heading, however, it should be mentioned that injuries to the abdomen, in which the muscles only are involved, sometimes require the use of the catheter, the bladder being rendered unable to expel its contents by reason of the pain which is produced on the patient's attempting to make expulsive efforts. Similarly, I have seen the same thing happen in a case of extravasation of urine largely occupying the abdominal parietes, where muscles, cellular tissue, and skin, were all involved in the sloughing and suppuration which ensued.

(2) Retention due to changes in the wall of the bladder by which it is rendered structurally incapable of performing its function, will be hereafter considered in speaking of vesical atony. The other causes of retention which depend on changes in the walls or contents of the bladder, include growths and calculi. The latter, by occasionally becoming impacted in the orifice of the urethra, may cause retention; a sudden stoppage in the stream of urine has often been noted as a symptom of stone.

(3) The most frequent cause of retention of urine is hypertrophy of the prostate gland. Reference has already been made to the precise changes which take place in the prostatic urethra as a consequence of this hypertrophy, whereby micturition is obstructed. When retention of urine occurs in males of advancing age, it is almost invariably due to this cause, a circumstance which must be borne in mind both in the selection of a catheter and in the manner of its introduction. Certain inflammatory changes in the prostate are sometimes the cause of retention. Of these, mention may be made of the follicular form of prostatitis, which is not uncommonly seen as a consequence of gonorrhœal urethritis. Such a retention may require the use of the catheter for its relief, and often this proceeding not only discloses the cause of the impediment, but removes it, by leading to the discharge of pus into the prostatic urethra, with immediate and permanent removal of the retention.

(4) An obstructed urethra may occasion retention in various ways. In young children it is most frequently due to the impaction of a calculus; if this be overlooked and not removed by incision, extravasation of urine may occur, and the calculus may make its escape by sloughing, as I have seen, into either perineum or scrotum. More rarely, retention in the infant is caused by the almost complete occlusion of the preputial orifice. In the adult, either a gonorrhœal or a traumatic stricture is the more frequent cause of retention. It not unfrequently happens that a complete stoppage to the discharge of urine suddenly takes place in a person who is suffering from

stricture, and it generally happens in the following way. Every person who suffers from stricture finds out by experience the maximum quantity of urine over which he can successfully exercise expulsive power; and as long as this quantity is not exceeded, the ability to expel the urine remains, although the stream may be exceedingly small or may even issue in drops. Should urine, however, from any cause, be allowed to collect in the bladder beyond the accustomed limit, the propulsive apparatus becomes disarranged by being called upon to do unaccustomed work, and irregular, spasmodic efforts take the place of that combined muscular action, which is necessary in the case of a person who, at the best of times, voids his urine under difficulties. This consideration is offered as explaining how retention may be regarded as an accident occurring in the course of a case of stricture, and how it is that spasm becomes superadded to permanent urethral obstruction.

Urethral spasm, independent of any organic change in the walls of the canal, is quite capable of occasioning retention of urine. Instances of this form of retention are most frequently seen in young men who, when suffering from gonorrhœa, have indulged freely in intoxicating liquors, or have exposed themselves to cold, as by lying or sitting on the grass or upon a damp seat. Spasm is thus excited in the muscles surrounding the membranous portion of the urethra; a condition not unlike that which we speak of as cramp, is aroused; the mechanism connected with micturition is disorganized; and thus the bladder is rendered incapable of voiding its contents. A predisposing cause to this variety of retention is a highly acid condition of the urine. Similarly, I have seen the same effect produced in the gouty by the passing of urine highly charged with crystals of uric acid, of a shape such as to irritate the mucous membrane and produce spasm of the muscular walls of the canals along which they have to pass. Hence, in all cases of this kind, it is important to free the urine from all probable causes of irritation. Retention may be caused by inflammation and suppuration around the urethra; these effects are most frequently seen in cases of acute gonorrhœa, and are often traceable to the use of irritating or too potent injections, or to the employment of bougies or other such like instruments during the acute stage of the disorder.

Amongst the rarer causes of retention may be mentioned the pressure of a displaced kidney. Dr. Gouley[1] has illustrated this by a case in which compression was exercised on the ureter (there being only a single kidney), partly by the kidney and partly by the bladder. After death the pelvis of the kidney was found enormously dilated and filled with urine, and encroaching upon the space behind the bladder.

Hysteria sometimes takes the form of retention of urine; numerous instances are recorded of deception with reference to this symptom, evidently prompted by the mental condition which in a large measure constitutes this peculiar neurotic disorder. It is sufficient to mention them.

Treatment.—When the bladder is incapable of being emptied spontaneously, it must be relieved artificially of the urine which it contains. Though the condition of the urine is frequently sufficient to convert impeded micturition into complete retention, the circumstances are exceedingly exceptional, under which treatment other than that of catheterization should be employed. After retention has once been relieved by the introduction of an instrument into the bladder, medical treatment may prevent the recurrence of such an emergency. It has been remarked by Sir James Paget, that "one of the best things about strictures to be learnt in the out-patient room, is the value of medical treatment, and of rules of living, in alleviating the occasional urgencies of the disease, and in enabling the patient to live in comfort and without catheters."[1] In some cases, when the symptoms of retention are not pressing, and when the history of the case warrants the assumption that the impediment depends upon some temporary occlusion of the urethra by inflammatory engorgement of the mucous membrane, to which spasm has been superadded, a hot bath and a full dose of laudanum, followed by wrapping the patient in warm blankets, are means which are sometimes successful in bringing about a natural discharge of the urine. Such treatment, however, is not to be recommended or to be continued when the symptoms of retention are at all urgent. When the case is further complicated by the existence of an organized stricture of some standing, delay may lead to serious consequences which might perhaps be averted by the timely use of the catheter. The late Mr. Guthrie[2] was in the habit of enforcing the use of the catheter by some very humorous and characteristic illustrations, concluding his observations on this subject with the remark, "I have always made it a rule to try and pass a catheter in every case of retention of urine. If it passes, so much the better; if it does not, the patient submits more cheerfully to the longer course of treatment."

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[1] Diseases of the Urinary Organs, p. 235.

There is a very simple expedient which often suffices in cases of retention due to organic stricture, which is not sufficiently resorted to. In many of these cases, the absolute occlusion of the urethra is, I believe, determined by the impaction within the stricture of a small fragment of inspissated mucus. I have frequently found that urgent retention may be relieved by the passage of a fine, filiform bougie. On withdrawing it, urine flows, and the patient, if placed in a warm bed, is able slowly but effectually to empty his bladder. Then, as a rule, medical treatment having reference to the allaying of spasm and inflammation, and to the correction of the condition of the urine, comes in most serviceably before any other treatment is required. In many cases I have found this proceeding successful even after ordinary catheterization has failed to give relief.

When retention is not occasioned by any object situated anterior to the bladder, catheterization will not be attended with any special difficulty. As a rule, the flexible or rubber instruments will be found admirably adapted for these purposes; not only do they occasion no damage to the parts along which they have to pass, but, should it be desirable, patients may be readily instructed in their use.

In senile retention due to an enlarging prostate, an appropriate instrument, either flexible or metallic, will most probably be required. These have already been described. In employing catheters under these circumstances, practitioners will not forget the great assistance which they may obtain from tilting the end of the instrument over the obstructing portion of the gland, by means of the finger in the rectum.

In retention arising from the various forms of stricture of the urethra, it may be necessary to employ instruments of very small calibre. These will be referred to in connection with the treatment of stricture of the urethra. When fine metallic instruments have to be used for this purpose, care must be taken that no force be exercised in introducing them, as otherwise a false passage may easily be made. I shall not further refer to the varieties of catheter used in the treatment of retention due to stricture, except to remark on the great usefulness of the tunnelled catheter introduced by Dr. Gouley (Fig. 1301). There have been very few cases of retention from stricture, in which I have not been able to introduce the fine whalebone guide into the bladder. When this is accomplished, there is very little difficulty experienced, or skill required, in sliding the fine catheter that accompanies the instrument through the obstruction, and thus withdrawing the urine.

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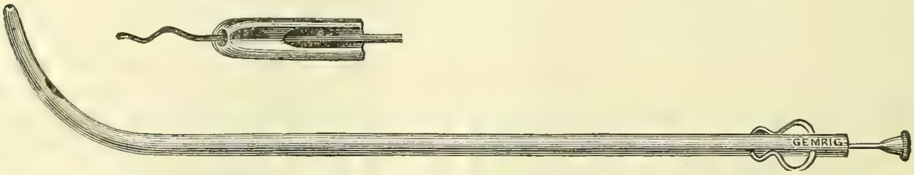
[1] On some Affections of the Urinary Bladder and Urethra. Med. Times and Gazette, April 10, 1858.

[2] Op. cit., p. 89.

Fig. 1301.



Gouley's tunnelled catheter.

To patients who are very intolerant of catheterization, or in whom there is spasmodic resistance to passing an instrument, an anæsthetic may be administered with advantage. As a rule, for these cases, I prefer chloroform to ether, as with the latter the stage of excitement is usually more prolonged—a point worthy of consideration where we have a distended bladder. I mention this, because I prefer, for surgical operations generally, ether to chloroform. In using anæsthetics for this purpose, Sir Henry Thompson's[1] observation should be borne in mind: "Let it be remembered that chloroform is administered, not for the purpose of permitting the instrument to be used with greater force than before, but in order to produce perfect anæsthesia and relaxation of the muscles." Retention of urine is far less common in females than in males; this is of course due to the comparative immunity of their short urethras from obstructive disease taking origin in the canal itself, or in the glands associated with it. The introduction of the female catheter, under ordinary circumstances, is an operation of no difficulty. In cases of distention of the bladder caused by uterine and ovarian tumors which are fixed in the pelvis, Sir Spencer Wells[2] observes that a small and long elastic catheter is sometimes required. Such an instrument is especially necessary in cases of tumor of the uterus, in which it is not rare to find the bladder drawn up nearly to the level of the umbilicus.

It will hardly be necessary to lay stress on the extreme gentleness with which all mechanical proceedings for the withdrawal of retained urine from the bladder, should be conducted. The employment of force is, under all circumstances, unjustifiable. Though retention of urine is an evil, unskilful catheterization may be a greater. If the catheter cannot be introduced with tolerable readiness, and without hemorrhage of any moment, an operator would be likely to do less harm by selecting one of the simpler methods of tapping the bladder presently to be described, than by persevering in his efforts to force an instrument in a direction supposed to correspond with that of the natural passage. When the bladder is once relieved, as for instance by the fine needle of the aspirator, the most important obstacle to catheterization—viz. tension—is at once removed, and will, most probably, not be allowed to recur.

In conclusion, it may be mentioned incidentally that patients have sometimes found themselves suffering from most urgent retention, under circumstances in which they have been unable either to introduce a catheter or to obtain professional assistance. I know cases in which the wire from a soda-water bottle and an iron skewer, each has done duty in "forcing" a stricture. A bougie made from an old clock-pendulum was recently shown me by a sailor, as an instrument modelled by himself, with which he had successfully combated an obstinate stricture that had previously resisted the attacks made on it with a gum-elastic catheter. It is not a long time ago that a man was admitted into my wards with retention, and a badly lacerated urethra, as a consequence of an attempt on the part of the mate of his ship to reach the bladder by the aid of a pointed piece of wood, roughly adapted to the shape of a bougie. Here the operator was more than professionally interested, inasmuch as he had occasioned the retention by kicking the patient behind the scrotum. The most remarkable piece of ingenuity of the kind that I can remember was in a case in which, after a patient had endured the unspeakable agonies of retention for over three days, an endeavor had been made to introduce through the urethra a piece of gas-piping, which had been devised, *in extremis*, for the purpose by the engineer of the ship. Unfortunately, however, this failed to effect its object. When I saw the patient, immediately on his arrival, I found the urethra much lacerated, and it was with considerable difficulty that I introduced a catheter, and removed a large quantity of the most fetid urine imaginable. Relief, however, came too late. the man dying shortly after his arrival, with convulsions and uræmic poisoning.

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[1] Op. cit., p. 178.

[2] On Ovarian and Uterine Tumors, p. 143. 1882.

Other cases are on record, in which, all such rough expedients having failed to relieve persons suffering from urgent retention, they have actually opened their bladders or urethras with knife or stylet, by either supra-pubic or perineal incision.

A case is narrated by Mr. Treves,[1] in which a seaman deliberately punctured his bladder in the median line above the pubis, with the small blade of a pen-knife, allowed the water to run out by the side of the knife, and then introduced a catheter into the bladder, through the wound. There he retained it until he found that he could pass an instrument by the urethra. The wound subsequently healed well, and the man recovered without a bad symptom.

INCONTINENCE OF URINE has been noticed as indicating the overflow of an already distended bladder, and also as a symptom of vesical irritability. In connection with the latter, it is most frequently met with in young children. Here incontinence is, for the most part, traceable to a variety of causes capable of disturbing, chiefly by reflected action, the innervation of the bladder. For the treatment of this form of incontinence, which is chiefly nocturnal, reference should be made to the section relating to irritability of the bladder.

There are other forms of incontinence which will require a brief notice. There is that of young adults, which seems as if it had grown up with them. Met with in such persons, it is productive of very great distress. In the case of domestic servants, it may become an insuperable objection to their obtaining employment. In many of these cases it is impossible to discover any tangible cause for its continuance. If it is merely a habit, it differs from others by the impossibility of breaking it off by any manner or kind of expedient. Males have been known to encircle the penis with iron rings for the purpose of exercising compression on the urethra. Instances are recorded, in which it has been necessary to remove such rings, and other rude expedients used for a similar purpose, by surgical operation. These cases are referred to as indicating the straits to which this state of incontinence may bring its victims.

Dr. Allbutt, of Leeds,[2] lays stress on the benefit that belladonna in full doses is capable of effecting in these cases. Chloral also has been found exceedingly useful. Dr. Allbutt has pointed out that this class of cases is analogous to that in which seminal emissions take place, independently, as far as is known, of any adequate cause. It is certain that many cases, both of urinary and seminal incontinence, are benefited by the same remedies. I have frequently found douching the spine before going to bed, with water as hot as could be borne, equally efficacious in both these conditions.

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[1] Lancet, Sept. 4, 1880.

[2] Lancet, Nov. 26, 1870.

Incontinence, when there is no retention, sometimes occurs in the course of prostatic hypertrophy. It is traceable to an alteration in the internal urethral orifice, brought about by the enlarging middle lobe pressing aside the lateral portions of the gland. In such a case, regular catheterization might be enjoined with the hope of effecting some change for the better in the vesical aperture. This condition is comparatively rare.

In the last place, it must be remembered that the ability to hold urine may be lost as the result of certain injuries involving the bladder or its neck. In the female, a vesico-vaginal fistula is the commonest illustration of such a condition. Fortunately, it is generally remediable by a plastic operation by means of which the aperture in the bladder is closed. In the same sex, incision or over-dilatation of the urethra, as for the extraction of calculi, is sometimes followed by incontinence. In the performance of operations of the kind, it is desirable to avoid incurring the risk of so unfortunate a consequence, and hence, if the stone is too large to be removed entire in this way, it is better to break it up with the lithotrite or to open the bladder in some other position.

As indicating the extent to which the female urethra may, with safety, be dilated for the purpose either of exploration or of extracting a stone, the following passage from a recent author may be quoted:—

> Simon, of Heidelberg, has made dilatation of the female urethra a proceeding applicable with scientific accuracy. The urethra can be dilated to a diameter of 1.9 to 2 centimetres, or $\frac{3}{4}$ inch, in women over twenty years of age; to 1.8 centimetres, or rather more than $\frac{11}{16}$ inch, in those between fifteen and twenty; and to 1.5 centimetres, or $\frac{5}{8}$ inch, in those between five and eleven. Under twenty years of age, these measurements may, in case of need, be exceeded by 2 or 3 millimetres. In no case does incontinence of urine result. Simon's statements have now been verified by general experience. Hence, since the average diameter of a man's right index finger at its thickest part is about $\frac{3}{4}$ inch (1.8 cm.), and of his little finger $\frac{5}{8}$ inch (1.5 cm.), it may be stated that we can safely dilate the adult urethra so as to admit the index finger, and the child's so as to admit the little finger.[1]

In some cases of incontinence, after dilatation of the female urethra, the bladder has eventually regained its power, even after the lapse of many months. The late Mr. Callender made an observation of the same purport. In one case which came under my notice, in which incontinence had continued for over a year, the return of power seemed to date its commencement from the introduction within the urethra, under ether, of the actual cautery. A sore was formed by the heated wire, and this subsequently cicatrized and contracted. Previously the urethra had been in a patulous condition, which no form of astringent or other application could improve.

Incontinence sometimes follows lithotomy in the male. It is probably due either to a too free incision of the prostate, or to some damage occasioned to the neck of the bladder in the extraction of the stone, whereby a large and perhaps irregular contraction is left. A case of this kind has been recorded under the section on wounds of the prostate. It is in their prevention that these forms of incontinence are of chief interest to the practical surgeon.

Where the incontinence is irremediable, it will be necessary for the patient to wear some contrivance by means of which the urine can be collected as it escapes from the urethra. Bags made of India-rubber, which may be concealed under the clothes, will be found best adapted for the purpose. Unless great care be taken in keeping these bags clean, they are apt to become very offensive.

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[1] Ogston, On the Operation for Stone in the Female Bladder. Edin. Med. Jour., July, 1879.

PARALYSIS OF THE BLADDER has already been alluded to in connection with retention of urine, of which it is a frequent cause. Reference has only been made, however, to those cases in which the paralysis is due to some injury or disease involving the cerebro-spinal centres; under such circumstances the affection of the bladder is secondary, and although the progress of the case will be much influenced by the manner in which the vesical lesion is managed, the return of power to the bladder is necessarily conditional upon the restoration of function to the nerve centres primarily involved.

It is to paralytic conditions depending on purely local causes that I would now draw attention. Just as we find that paralysis of a limb or a muscle may be determined by some temporary nerve-pressure, or the like, so may the bladder be similarly affected.

Paralysis of the bladder, either temporary or permanent, is a not unfrequent consequence of retention of urine and over-distension of the viscus.

There can be no doubt that in many of these cases the subsequent want of power is distinctly traceable to the pressure which has been exercised, not only upon the nerves supplying the bladder, but also on the involuntary muscular fibres which they control. In this respect the bladder resembles what not unfrequently takes place in a portion of intestine which has become strangulated. After the constriction has been relieved by operation, the gut may remain in a paralytic condition which does not disappear although gangrene may not occur. In other instances, many days may elapse before the intestine recovers from the semi-paralyzed state which remains as a consequence of the compression exercised upon it. In the corresponding condition of the bladder we have no structural alteration, function is suspended, and no ill results need follow. We have illustrations of this form of local paralysis at all ages, and it is not to be confounded with those senile changes to which the term atony is more correctly applied.

In the same way can be explained those cases of temporary paralysis of the bladder following labor, where the viscus may not only have been compressed by retained urine, but also by the head of the child during its descent through the pelvis.

ATONY OF THE BLADDER is a condition coincident with either natural or premature senility. A badly-used organ will often assume the features of an old one. In true atony, there is a distinct weakening or thinning of the muscular coat of the bladder. It may come on in what may be called the ordinary course of wear and tear of the organ. The bladder, in this affection, may gradually lose the power of emptying itself, and, independently of any obstruction, may present itself as a swelling above the pubes: or this condition may come on, as it most frequently does, during the progress of an enlargement of the prostate gland when the bladder either fails gradually or suddenly breaks down. In many cases of prostatic enlargement, with distended bladder, the latter has been found to be little else than a flaccid bag, with scarcely a trace of normal muscular fibre remaining. We have, therefore, many points of resemblance between the temporarily paralyzed bladder and the atonied one. The first, however, may recover its normal condition; the other can do so but imperfectly. As the disused muscle may shrink in bulk, and become structurally altered for the worse, so may the unused bladder. Hence, in all cases of temporary paralysis, efforts should at once be made to arouse action and avert structural retrogression, for in this way the paralyzed bladder may become an atonied one. On the occurrence of retention of urine, as indicated either by the signs which usually accompany a distended bladder, or by the occurrence of incontinence or overflow, regular catheterization must be employed, with the view of rendering such assistance to the act of micturition as may enable the bladder to regain the power lost during its period of inaction. In this way many a patient may be saved the distress of an atonied bladder in addition to some other urinary complication. Careful and regular catheterization is the great remedy both for vesical paralysis and for the prevention of atony.

The introduction of a catheter as often as may be necessary is to be preferred to the retention of an instrument, for, as Hey,[1] of Leeds, observed, "a patient sooner regains the power of emptying his bladder by the natural efforts, when the catheter is withdrawn after each extraction, than when it is suffered to remain constantly in the urethra."

For restoring the tone of the bladder, other expedients have been resorted to. The cold douche, applied over the region of the bladder, or to its interior by means of an irrigator, has been found of much service. In addition to this, medicines, such as iron, nux vomica, and strychnine, have been administered, with varying degrees of success.

Dr. Glynn, of the Liverpool Royal Infirmary, speaks very highly of the tincture of cantharides, given in twenty minim doses, in cases of paralysis of the bladder arising from affections of the spinal cord; it is an old-fashioned remedy, which, in addition to its diuretic properties, probably exercises, as suggested, a direct, stimulating action on the bladder by its presence in the urine. Professor Von Langenbeck has found considerable benefit in these cases from the use of hypodermic injections of ergotine,[2] and in two instances in which this mode of treatment was tried at my suggestion, the patients certainly appeared to gain muscular power; both of them suffered from impeded micturition, with considerable prostatic enlargement.

Galvanism has also been successfully employed in this class of affections, where disorganization of the nerve-centres controlling micturition has not taken place. Althaus[3] has found benefit from its external application over the region of the bladder. Coulson[4] considers that the induced current should alone be employed, one pole being introduced into the bladder, and the other applied over the lumbar vertebræ or the hypogastric region. The electrode for introduction into the bladder should consist of an elastic bougie, terminated by a metallic knob and having along its centre a conducting wire.

The introduction of an ordinary flexible bougie along the urethra is often of service in these cases. Under ordinary circumstances, as the instrument is about to enter the bladder, most persons generally experience an urgent desire to micturate. This fact has been advantageously utilized in arousing the dormant powers of a temporarily paralyzed viscus.

SPASM AND NEURALGIA OF THE BLADDER are conditions of disturbed innervation which, for the most part, are traceable to the presence of some other disease, or to a disordered condition of the urine.

SPASM.—Pure spasm of the bladder has sometimes been observed in children suffering from other indications of chorea. In illustrating this affection, Van Buren[5] speaks of it as a distinctly choreic condition of the bladder, which, though rare, has probably often been overlooked.

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[1] Practical Observations in Surgery, p. 430.

[2] Medical Times and Gazette, April 7, 1877.

[3] British Med. Journal, Nov. 18, 1871.

[4] Op. cit., p. 271.

[5] Op. cit., p. 230.

Vesical tenesmus or cramp frequently accompanies various inflammatory diseases. As occurring in rheumatic and gouty subjects, this affection has already been referred to, as described by Civiale, Mercier, and other French authorities, under the title of *contracture du col vésical.* Met with in such subjects, the distressing symptoms of cramp or contraction felt about the neck of the bladder are generally traceable to some condition of the urine, which is capable of exciting irritation. In the great majority of cases, when the muscular parts concerned in micturition are in this way disturbed, careful examination will disclose some cause. Hence it is better to speak of vesical spasm as a symptom rather than as a disease.

In the *treatment* of this affection, everything will depend upon whether a cause for it is discoverable or not. When it occurs as a symptom of chorea, tonics, cod-liver oil, and country air will be indicated. In other cases, a careful examination of the urine will generally point out the proper treatment to be employed. Belladonna is probably the most useful medicine for controlling vesical spasm. It may be administered either internally or by local application to the perineum. Dr. Reliquet, of Paris,[1] has advocated the use of the continuous electric current in certain spasmodic affections of the bladder.

NEURALGIA of the parts constituting the neck of the bladder, including the prostate, sometimes occasions much distress. It is generally met with in nervous subjects who are disposed to take a very gloomy view of their prospects. Like other forms of neuralgia, it may be the result of some lesion, as when damage is done to the neck of the bladder by unskilful or forcible catheterization. Patients who suffer from oxaluria frequently complain of severe pain, obviously neuralgic, about their bladders. Again, there are cases in which there seems to be an entire absence of any cause for these pains, and which, for the want of a better name, have been referred to as instances of "insanity of the prostate." In neuralgia of the vesical neck, the pain is paroxysmal and intermittent in character, in this respect resembling similar affections in other parts of the body. It is often met with in persons who for a considerable period of time have either naturally or unnaturally stimulated, and given unrestrained license to, their sexual desires. This affection may be accompanied with frequent desire to urinate, and it is often associated with one or other of the conditions which have been referred to as excitants of an irritable bladder.

The character of the vesical irritability which accompanies this disorder is peculiar. It is seldom nocturnal, and during the daytime it is largely influenced by circumstances which tend agreeably to distract the attention of the patient. Persons who suffer in this way are, as already mentioned, of a highly nervous temperament, and we find them frequently inspecting their urine and taking alarm at a variety of appearances which it may quite naturally present. Climate and the presence or absence of dyspepsia exert the most powerful influence for good or ill over disorders of this nature. On one day these patients are comparatively well, whilst the next finds them sunk in the depths of despair, and under the impression that they are suffering from stone or some mortal affection. That many cases of this kind are occasioned by some malady which is the source of the disordered sensations, there can be no doubt, but even allowing for these, there still remains a considerable proportion which cannot be thus explained. It has been observed by Dr. Owen Rees,[2] that improved pathology is rapidly lessening the number of reported cases of diseased bladder; and of these, what are spoken of as cases of nervous disorder form a considerable portion.

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[1] Practitioner, vol. ix. p. 98.

[2] Op. cit., p. 47.

In the *treatment* of these affections careful search must be made for any cause which may be remediable. In the absence of such cause, careful regulation of the diet, sufficient employment for both body and mind, and change of scene and climate, are all means which are likely to be of service. In the absence of stricture of the urethra, or other conditions requiring the introduction of instruments into the bladder, I do not consider that functional nerve-disturbances of this kind are benefited by the frequent use of bougies. On the contrary, it is desirable to avoid that concentration of thought upon the sexual organs, which is often a prominent feature of these cases. Where the case is complicated, as it sometimes is, by a frequent and unnatural flow of seminal fluid, the irrigation of the urethra with cold water, from the prostatic portion forwards, is generally followed by good results.

The mental aspect of these cases must not be overlooked. Plenty of encouragement will be necessary. When the patient is convinced that he is not suffering from any serious organic disease, he will often take courage. If a person be weighed down by the dread of an imaginary disorder, his confidence will not be gained by simply telling him, without a reasonable explanation, that he is deceiving himself. On the contrary, by so doing he will rather be driven into the hands of those by whom his fancies will be encouraged and his alarms intensified. These patients require reassurance, and this must be given them, not by dissembling, but by such a rational explanation of their condition as an educated medical man is capable of affording.

PUNCTURE OF THE BLADDER.

Paracentesis vesicæ is an operation of very ancient date, and has been practised in various ways to fulfil either temporary or permanent purposes. A history of the proceeding would show that from time to time there has been considerable fluctuation in opinion as to the best way of performing it.

In opening the bladder, advantage is taken of the partial manner in which it is invested by the peritoneum, to effect this object without detriment to its serous covering. Having regard to this object, the bladder may be opened as follows: (1) above the pubis, (2) by the subpubic operation of M. Voillemier, (3) through the symphysis, (4) from the perineum, (5) from the rectum.

TAPPING THE BLADDER ABOVE THE PUBIS.—It will be found that there is a space immediately above the pubic bone, where the anterior surface of the bladder may be reached with a trocar, or even the end of the finger, without wounding the peritoneum. Though this interval varies much in extent, and is increased by the degree to which the bladder is distended, it is a condition of this operation, when undertaken from this point, that the puncture shall be made immediately above the pubis. Instances have occurred, in which, this rule having been disregarded, the cavity of the peritoneum has been opened.

The supra-pubic operation is probably the safest and most convenient one in cases in which it is tolerably obvious that it will only be required for temporary purposes until the bladder can be reached by the natural passage. For fulfilling such an object, the aspirator will be found a most useful instrument. Aspiration of the bladder above the pubis has now been so extensively practised, and with such good results, that no one would be at all likely to question its utility as a temporary expedient. If in using the instrument, the finger be for a moment pressed firmly above the pubis, the passage of the needle is rendered almost painless. In this respect it strongly contrasts with the distress occasioned by attempts at catheterization, where the difficulty is increased by the tension thrown on the stricture by the largely distended bladder.

Aspiration may, if necessary, be repeated with impunity. Dr. W. Brown[1] remarks: "We used the aspirator daily, and on some occasions the pain was such as to require the operation to be performed twice in the day." Though reference is made to cases such as these for the purpose of illustrating the safety which attends repeated aspiration of the bladder, they at the same time would seem to indicate that the conditions were such as to render some more permanent method of giving vent to the urine desirable. A case has been recorded by Dr. W. Macfie Campbell,[2] in which urinary extravasation along and around the track of the needle followed its reintroduction; a circumstance which seems to suggest that when the operation has to be repeated, this should be done before anything like extreme tension of the viscus has been reached.

The bladder may also be tapped in this situation with an ordinary trocar, the canula being left in and retained by tapes. Here the object in view is of a more permanent character. Mr. Thomas Smith,[3] in advocating this proceeding, remarks: "I am the only surgeon connected with a metropolitan hospital, who has systematically adopted the supra-pubic puncture for the relief of retention of urine, in preference to the rectal operation." In support of this proceeding, as against puncture through the rectum, it is said, that it is easier of performance and quite as safe, that it does not interfere with defecation, and that there is no difficulty in retaining the canula or in replacing it; and further, that the management of the canula, as well as the mechanism for the discharge of urine, may be placed under the control of the patient. The only objection raised to the operation seems to be on the ground of an increased liability to urinary extravasation, which it is said to incur. Such a conclusion, however, is not warranted by the cases illustrating Mr. Smith's practice.

Referring to this operation, Dr. Gross[4] remarks:—

> Mr. Abernethy, who gave a decided preference to this mode of puncturing the bladder, often performed the operation with no other apparatus than a pocket scalpel and a lancet; he did not even always, it seems, leave a canula in the organ, the collapse of the sac sometimes preventing him from finding the opening he had made into it. Notwithstanding this he never witnessed any ill effects from the procedure, such as effusion of the urine into the connective tissue or the peritoneal cavity.

The operation may be performed with an ordinary trocar and canula, a small incision through the skin having been previously made with the knife. Through the canula, an elastic India-rubber catheter should be introduced and fixed in. For permanent wear, a shield of rubber or vulcanite may be attached, with a belt round the abdomen. This operation has been practised at all ages with good results. The late Mr. Wakley[5] recorded a case in which it was successfully performed on a child of the age of twenty months, catheterization being impossible by reason of the tension which immediately followed an injury to the perineum. Mr. Smith also remarks: "I have, at the Great Ormond St. Hospital, on three occasions, punctured the bladder for retention in children, with favorable results as far as the immediate and subsequent relief of the retention was concerned."

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[1] Brit. Med. Journal, May 23, 1874.

[2] Ibid., February 21, 1880.

[3] St. Bartholomew's Hospital Reports, 1881.

[4] Op. cit., p. 132.

[5] Lancet, vol. ii., 1850.

The following case in the practice of my colleague, Mr. Mitchell Banks, illustrates the employment of supra-pubic puncture, under circumstances of emergency, in connection with a rupture of the urethra:—

F. J. A., a man aged 27, received an injury to his perineum while at sea, followed by the passing of blood, and other signs of rupture of the urethra. Four days after the accident it was found necessary to empty the bladder, in consequence of the swollen condition of the penis and scrotum. The surgeon of the ship tapped the bladder above the pubis, and inserted a tube into the opening. On arriving at the Liverpool Infirmary, six days after the accident, the patient was found to be suffering from rupture of the urethra and extravasation of urine. Mr. Banks made incisions where necessary, and substituted for the supra-pubic puncture a communication with the bladder by perineal incision. The patient made a good recovery.

A modification of the supra-pubic puncture was some years since introduced by Sir Henry Thompson,[1] for the treatment of certain advanced cases of prostatic disease, attended with much vesical irritability. Here the operator cuts down, immediately above the pubis, on the end of a sound passed into the bladder by the urethra, and by means of this introduces an elastic tube, which is then permanently fixed within the viscus. Provision is in this way made for reaching a bladder which might not present any prominence above the pubis, and when, consequently, tapping with the trocar and canula, as previously described, could not be undertaken with safety.

Subpubic Operation of M. Voillemier.[2]—This consists in plunging a trocar into the bladder through the anterior wall, entering it above the penis after having drawn that organ downwards and backwards. The suspensory ligament is thus put upon the stretch and perforated, the instrument entering the viscus in the median line and beneath the arch of the pubis. This proceeding does not seem to have at all commended itself to surgeons. It is not easy of performance; the position of the opening is neither a convenient nor a comfortable one; nor can I imagine the existence of any circumstances which would seem specially to indicate its selection.

Puncture through the Symphysis Pubis.—Puncture of the bladder through the symphysis was first proposed by Dr. Brander, of Jersey, in 1825; but although it has been successfully performed on several occasions, it is not a proceeding which has found general favor.

The operation consists in perforating the symphysis with a trocar at about its middle, and thus entering the bladder at a point where it is uncovered by peritoneum. The instrument should be directed obliquely downwards and backwards towards the sacrum. A piece of flexible catheter is then introduced through the canula, and retained by a tape. It should not be forgotten that, in a person of advanced age, considerable difficulty might be experienced in penetrating the symphysis by reason of the ossification of the intrapubic cartilage. It would, however, as Coulson suggests, be possible to overcome this difficulty, should the operation be selected for other reasons as the most appropriate to the case under consideration, by drilling a hole through the ossified cartilage by means of a suitable instrument.

Tapping the Bladder from the Perineum.—From this position the bladder may be reached, either indirectly by opening the membranous urethra, or directly by puncture, either through or by the side of the prostate gland.

There are certain conditions of obstruction in which, for several reasons, an opening from the perineum may be the one most desirable to secure. The condition of the prostate gland may render the making of an opening from the rectum well nigh impossible. In cases of stricture of the urethra, complicated with urinary fistulæ, with a perineum more or less disorganized by inflammatory exudation, and with but a remote prospect of establishing the continuity of the natural passage after relieving the retention, an opening from the perineum, directly communicating with the bladder through the prostatic urethra, is, probably, the best substitute for a urethra, which could only be kept patent by most persevering efforts on the part of both the patient and the practitioner.

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[1] Op. cit., p. 287.

[2] Lancet, Dec. 19, 1863.

It was for conditions such as these, viz., irremediable and complicated strictures, that Mr. Cock,[1] of Guy's Hospital, advised the operation with which his name is most properly associated. Though improved instruments, and a largely increased number of skilled manipulators, have greatly reduced the number of cases in which it is necessary to substitute an artificial for the natural passage, there still remain isolated instances in which this operation is capable, not only of substituting comfort for distress, but of prolonging life. I am in the habit of occasionally seeing a patient upon whom I performed this operation some ten years ago. For five years previously he had endured all the vicissitudes which commonly fall to the lot of the subject of an at times impassable stricture. Since the adoption of this treatment, he has enjoyed perfect health and comfort, at the expense of micturating through his perineum.

In the performance of this operation I do not think that the surgeon can do better than follow the directions of Mr. Cock. They have been subject to some modification by various practitioners, but I cannot say that any material improvement has been suggested. An operation which is likely to be of permanent utility is best described in the words of the originator:—

> The only instruments required are, a broad double-edged knife with a very sharp point; a large silver probe-pointed director, with a handle; and a canula or a female catheter, modified so that it can be retained in the bladder. The patient is to be placed in the usual position for lithotomy; and it is of the utmost importance that the body and pelvis should be straight, so that the median line may be accurately preserved. The left forefinger of the operator is then introduced into the rectum, the bearings of the prostate are carefully examined and ascertained, and the tip of the finger is lodged at the apex of the gland. The knife is then plunged steadily but boldly into the median line of the perineum, and carried on in a direction towards the tip of the left forefinger, which lies in the rectum. At the same time, by an upward and downward movement, the vertical incision may be carried in the median line to any extent that is considered desirable. The lower extremity of the wound should come to within about half an inch of the anus. The knife should never be withdrawn in its progress toward the apex of the prostate, but its onward course must be steadily maintained, until its point can be felt in close proximity to the tip of the left forefinger. When the operator has fully assured himself as to the relative positions of his finger, the apex of the prostate, and the point of his knife, the latter is to be advanced, with a motion somewhat obliquely either to the right or to the left, and it can hardly fail to pierce the urethra. If in this step of the operation the anterior extremity of the prostate should be somewhat incised, it is a matter of no consequence. In this operation it is of the utmost importance that the knife be not removed from the wound, and that no deviation be made from its original direction, until the object is accomplished. If the knife be prematurely removed, it will probably, when reinserted, make a fresh incision and complicate the desired result. It will be seen that the wound, when completed, represents a triangle; the base being the external, vertical incision through the perineum, while the apex, and consequently the point of the knife, impinges on the apex of the prostate. This shape of the wound facilitates the next step of the operation.

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[1] Guy's Hospital Reports, 3d Series, vol. xii. 1866.

The knife is now withdrawn, but the left forefinger is still retained in the rectum. The probe-pointed director is carried through the wound, and, guided by the left forefinger, enters the urethra and is passed into the bladder. The finger is now withdrawn from the rectum, the left hand grasps the director, and along the groove of this instrument the canula is slid until it enters the bladder.

The operation is now complete, and it only remains to secure the canula in its place with four pieces of tape, which are fastened to a girth round the loins. There will probably be no escape of urine until the stylet is removed from the catheter. A direct communication with the bladder has now been obtained, and the relief to the patient will be immediate. Unless the kidneys have become irremediably disorganized, we may confidently anticipate a favorable result ; and the restoration of the urinary organs will be more or less complete, in proportion as the obstructed portion of the urethra is more or less amenable to the ordinary judicious treatment of stricture. The canula may generally be retained in the bladder for a few days, and, if the state of the urine renders ablution necessary, the viscus may be frequently washed out. The canula may then be removed, cleaned, and reintroduced. A flexible catheter is sometimes more desirable and congenial to the feelings of the patient than a metallic canula.

Puncture of the bladder directly from the perineum is not a proceeding which is now practised for the relief of retention due to stricture of the urethra, or of any of the complications arising therefrom. Where an opening is necessary, and the prostate is normal in size, a perineal puncture of the bladder either through or by the side of the prostate does not offer any advantages over Cock's operation of opening the urethra at the apex of the gland, as already described, and is a hazardous proceeding.

Where, however, the prostate by reason of its hypertrophy becomes the hindrance to micturition, Cock's operation is not to be advised, inasmuch as the obstacle is situated *behind* the point at which the urethra is tapped, and hence it is under the circumstances of a distended bladder depending upon an enlarged prostate, that the desirability of direct paracentesis from the perineum, independent of the line of the urethra, may be considered.

The following case occurring in my practice illustrates this operation :—

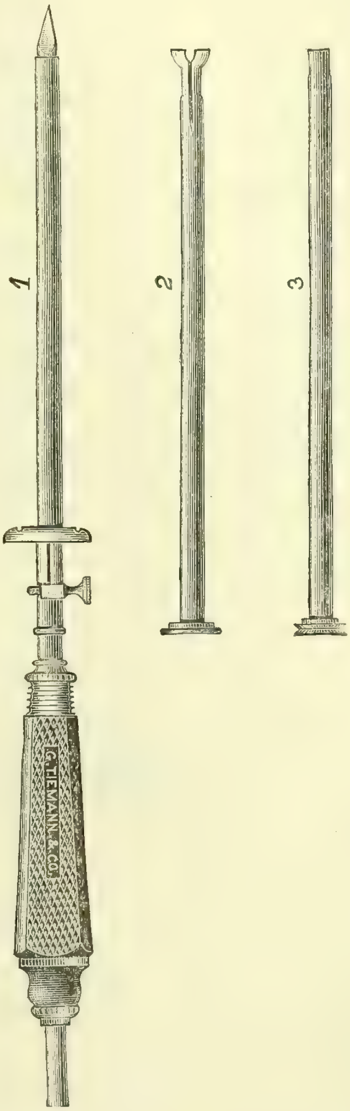
N. D., aged 84, was admitted into the Liverpool Royal Infirmary, under my care, on Nov. 4, 1881. My house surgeon, Mr. Laimbeer, found him bleeding from attempted catheterization, with an enlarged prostate and a distended bladder. Perceiving the urgency of the case, and finding that catheterization was impracticable, he emptied the bladder with the aspirator above the pubis. Afterwards I saw the patient, and, having administered ether, succeeded in passing a catheter. Recognizing the difficulty of the situation, and the necessity for establishing a permanent opening through which the urine could escape, I determined to tap the bladder from the perineum. I therefore withdrew the catheter without letting any urine escape, in order that I might tap a distended and not a flaccid viscus.

Taking a trocar specially made for the purpose, I introduced it in the median line of the perineum, three-quarters of an inch in front of the anus, and pushed it steadily through the prostate into the bladder, at the same time retaining my left forefinger in the rectum as a guide. On withdrawing the trocar, a large quantity of ammoniacal urine escaped. The canula, being provided with a shield, was secured in its place by tapes, much in the same way as a tracheotomy-tube. A piece of India-rubber tubing was attached to the portion of canula which projected beyond the shield, and conveyed the urine into a vessel placed at the side of the bed. Through this tubing urine continued to dribble. The patient was at once made comfortable by this arrangement, and in forty-eight hours he was up—an important matter with old persons—and sitting in an easy-chair. To permit of this, the rubber tubing was shortened during the daytime, its end being tucked through a light abdominal belt where it was compressed by a small pair of bull-dog forceps, which were removed when the patient desired to pass water. He was quite as well as most men are at eighty-four years of age. He got up daily, took his food, slept comfortably on either his back or his side without any narcotic, and was quite free from any urinary inconvenience other than wearing his tube. During the night, his sleep was not broken by calls to micturate or pass catheters, as his urine ran off by the tubing as it was excreted, while in the daytime, whilst up and about, his act of micturition practically resolved itself into something equivalent to the turning of a tap. His urine, which had been fetid and ammoniacal, became normal, the bladder being readily washed out by applying a syringe to the canula twice a day. On two or three occasions the canula having accidentally slipped out, whilst the tapes were being changed, was readily replaced by the nurse. The somewhat enthusiastic manner in which the patient compared his former with his later condition, cannot be passed entirely unnoticed. For about six weeks my patient passed urine through the prostatic canula. His health rapidly improved, and he was able to go about as if nothing ailed him. Then it was noticed that urine in gradually increasing quantities began to flow through the natural passage, so much so as to lead me to infer that, for some reason or other, the prostate was ceasing to obstruct micturition.

On January 28, 1882, I removed the prostatic canula; the puncture healed in the course of a few days, and with this the bladder gradually proceeded to recover its natural function and power. During the daytime he now (April 4) held his urine for two or three hours, and at night got up twice and sometimes thrice to micturate; all functional symptoms of enlarged prostate had ceased to exist.

On the day of his admission into the infirmary, when the puncture was made, rectal examination, practised both by my house-surgeon, Mr. Laimbeer, and by myself, left no doubt that the prostate was greatly enlarged. Upon this point there could be no other conclusion. Now we found that the enlargement had almost disappeared; in fact, the finger, by the rectum, discovered but little that could be regarded as abnormal—a strong contrast to what had previously existed. Here, then, we had a case in which a surgical proceeding on an enlarged prostate was followed by its rapid atrophy, a result which, as far as I know, had not been noted before. It may be urged that rectal examination afforded evidence only that one side of the enlarged gland had thus become reduced; but it must be remembered that a return of the power and function of micturition warranted the conclusion that a corresponding change had taken place on its vesical aspect.

Fig. 1302.



1 represents the trocar with canula complete. A piece of India-rubber tubing is to be attached below the collar of the canula on withdrawal of the trocar, to convey the urine into a receptacle. 2. Silver canula, which is introduced into tube of 1, to form a probe end, and for retaining it. 3. A plain silver tube with which to clear tube 2, in case it should be blocked up.

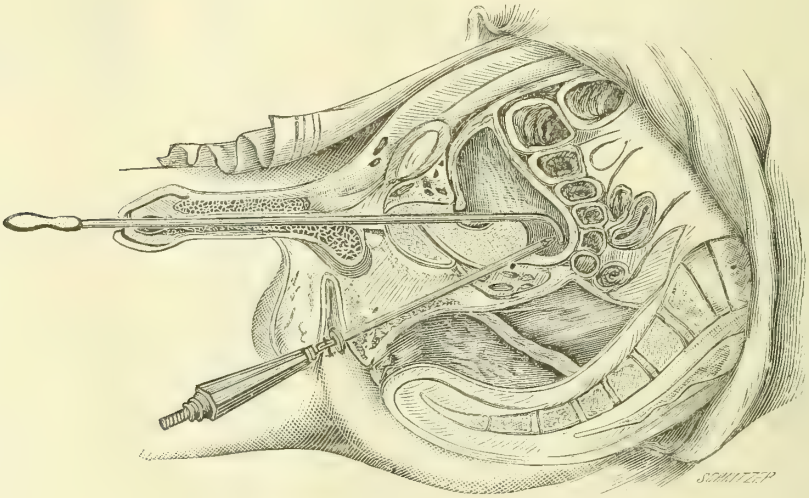
I annex an illustration (Fig. 1302) of the instruments which I have devised for this operation, and which have been made for me by Messrs. Krohne & Sesemann, of London.

The trocar is hollow, and urine escapes through it as soon as it enters the bladder. The shield on the tube (1) is movable, and can be fixed at any desired position to suit the varying depth of prostate and tissues. The instrument is also adapted to other purposes.

The only alternative, in the case just narrated, would have been to tap the bladder above the pubis and establish a permanent opening. I consider that the method adopted had some decided advantages. Tapping the bladder above the pubis is not unlike opening an abscess at its least dependent point. Urine ascends the canula at a disadvantage as far as concerns the carrying off with it of the products of cystitis, which in these cases are present in some degree. My object in planning this operation was to obtain, not only the most convenient position for the external opening, in all postures of the body, but further to provide what I can best describe as a short, low-level urethra, adapted to the altered relations of the bladder and prostate when the latter becomes enlarged, for the purpose of securing the most complete drainage. When this operation is practised on a distended bladder there is no difficulty or danger in its performance; it is quite as simple as any of the other methods of reaching the organ. I believe, too, that this method is applicable when, though there is no retention, a constant state of vesical irritability and inflammation render it essential that a permanent opening should be established. Under these circumstances, before introducing the trocar, a sound should be passed into the bladder and reversed, so that the beak may rest in the depression behind the prostate. It is against this that the point of the trocar should be directed.

In connection with the operation of tapping the bladder through the hypertrophied prostate, it is interesting to observe that a considerable reduction in the size of the gland followed upon the retention of the canula. Whether the constant pressure of the tube, acting possibly as a seton, in any way contributed to this result, is conjectural. I have known a similar change follow the incising of a large prostate in lithotomy, and a case has been communicated to me by Mr. Weston, one of the surgeons to the Stafford Infirmary, in which he punctured the bladder twice through an enormously large prostate, and retained a canula, with the result that the growth considerably decreased in size, and ceased permanently to obstruct micturition. Such changes in the

Fig. 1303.



Tapping the bladder from the perineum through an enlarged prostate.

hypertrophied gland are not, however, limited to cases in which it has been punctured and a canula retained in the course of a paracentesis vesicæ. In some of the cases recorded by Mr. Thomas Smith,[1] the wearing of the supra-pubic tube was followed, after the lapse of weeks or even months, by a return of the power of micturition through the natural channel, indicating that for some reason or other the prostate had ceased to obstruct. To quote Mr. Smith's words upon this point—one of considerable importance—"cases are here recorded where in great prostatic enlargement the power of voluntary micturition *per penem* was entirely regained."

That the substitution of an almost involuntary act for one in which all the ordinary as well as the extraordinary muscles of micturition are engaged, may be followed by a change of the nature of atrophy, in which the large prostate shares probably in a degree proportionate to the obstruction which it has created, is by no means impossible.

Whatever may be the explanation, the good effects which follow the establishing of an artificial drain for the urine are by no means limited to immediate relief, but are often permanently beneficial.

PUNCTURE FROM THE RECTUM.—In the last place, the bladder may be punctured from the rectum. This is an operation which has to a great extent been superseded as a temporary resource in cases of retention, by aspiration above the pubis. As a permanent means for supplanting the normal channel, when this is rendered useless by disease, it is not generally to be recommended, for the reasons that (1) the presence of a canula in the rectum is an obstacle to defecation, (2) the patient is necessarily confined to the recumbent posture, and (3) there is great difficulty in reinserting the tube in the bladder, when this is necessary. When the prostate is not large, although this operation may be easier of performance, it is not as good an expedient as tapping the urethra at the apex of the gland; while, if there is hypertrophy of the prostate, rectal puncture may be impossible of accomplishment.

Before the days of aspiration and of improved urethral instruments, this operation seems to have been resorted to with tolerable frequency. Mr. Cock's[2] communication on this operation is perhaps the most important which we possess, and at the time of its publication did much towards reviving and popularizing it. In this proceeding the left index finger is introduced into the rectum for the purpose of feeling, beyond the prostate, the bulging posterior wall of the bladder. Into this the trocar is to be thrust, precisely in the middle line. This manipulation is most safely effected by either withdrawing the point of the trocar well within the canula as it is passed along the left index finger to its destination, and then projecting it; or by first using a blunt trocar with the canula, until the proper position for the puncture is ascertained, when a sharp trocar is to be substituted and the operation completed. After the bladder has been punctured and the trocar withdrawn, a second tube, with an expanding end, may be passed within the first to secure the retention of the apparatus in the bladder. (Fig. 1304.)

The canula is held in position by tapes passed through holes in its shield. By means of some rubber-tubing attached to the canula, the urine is conveyed away as it passes, and thus the patient is kept dry.

It may be mentioned that the bladder has been punctured from the urethra through the cause of obstruction, and several instruments for this purpose have been devised, notably one by Dr. S. J. Kisch.[3] Though it may be a matter of satisfaction to a patient to know that his retention has been relieved by means applied in correspondence with the natural direction, yet such proceedings are necessarily far more difficult of accomplishment and more hazardous than any of the methods of reaching the bladder which have hitherto been described. Although it may appear a simple thing to pass a canula to the face of a stricture or an enlarged prostate, and then project a catheter-trocar through it, and so enter the bladder, yet there is an uncertainty about such a proceeding which does not attend the more generally recognized operations of vesical paracentesis.

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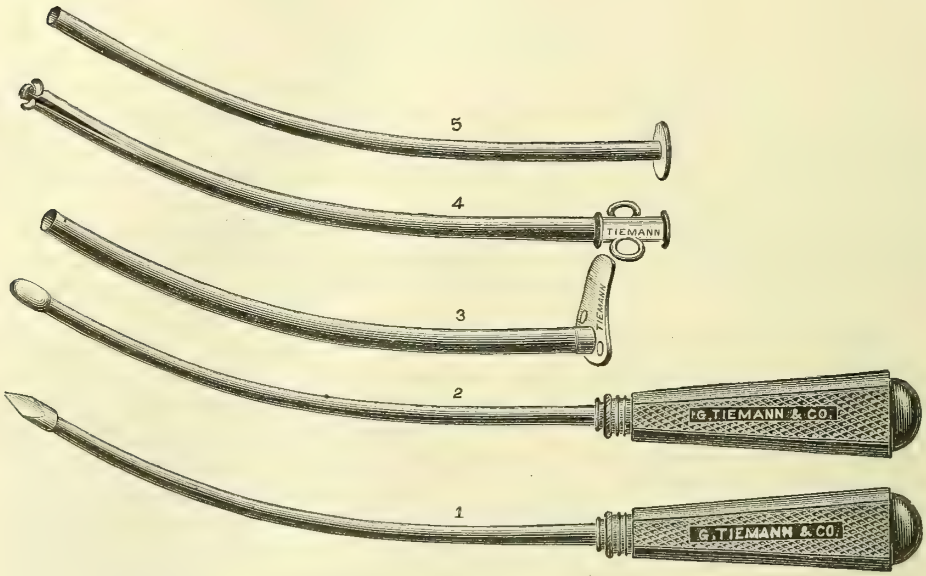
[1] Op. cit.

[2] Med.-Chir. Trans., vol. xxxv.

[3] Punctio Vesicæ verrigt met den troiquart-catheter. 1849.

Fig. 1304.



Instruments for tapping the bladder through the rectum: 1, inside canula; 2, middle canula; 3, outside canula; 4, blunt trocar; 5, sharp trocar.

APPENDIX.

PROSTATOTOMY.

In connection with the treatment of hypertrophy of the prostate, I wish to refer to some observations recently made relative to the practice of prostatotomy.

The class of cases in which this proceeding has already been advantageously employed, includes those in which there is unusual difficulty in introducing the catheter; in which hemorrhage almost constantly attends the use of this instrument; in which withdrawal of the urine is followed by no sense of relief; and in which the bladder, by the constant presence within it of pus and tenacious mucus, is converted into little else than a chronic abscess-cavity through which urine percolates. These conditions represent types of the disorder which are rapidly fatal. The operation which I have practised[1] under these circumstances, consists in opening the membranous urethra from the perineum, and then, introducing a probe-pointed knife along the prostatic urethra, in making a section of the obstructing portion of the gland in the median line. In doing the operation, it is not desirable to make an opening larger than will admit the index finger from the perineum into the prostatic urethra; such an opening is completely filled up by the drainage-tube that is subsequently used, and consequently but little fear of hemorrhage need be entertained. The drainage-tubes which I am in the habit of employing, after section of the prostate has been effected, are double: that is to say, a soft-rubber catheter is passed into the bladder, and retained within a stiffer, gum-elastic one. There are many advantages connected with this arrangement, as the inner, soft-rubber tube adapts itself to the inequalities about the floor which often exist in bladders that have long suffered from the effects of an obstructing prostate. In this way a sacculated bladder which has been opened from the perineum, as for a lithotomy, may be thoroughly drained. Very considerable importance in the after-treatment is attached to a prolonged use of the drainage-apparatus, the object being to render the section of the prostate not a temporary one, as after lithotomy, but permanent. Hence I am in the habit of retaining these tubes for six, eight, or even twelve weeks. If after such periods of continuous drainage, on removing the tube from the perineal wound, I find that a soft catheter can be made to enter the bladder easily by the natural route, or if, as sometimes happens, urine forces its way in spite of the perineal tube along the natural passage, I regard these as indications that the object in view has been obtained. The regular passage of the bougie along the *whole* length of the urethra is continued until the perineal wound has soundly healed, a process which usually takes place rapidly. In offering an explanation of the satisfactory results which have followed this method of treatment, I think that not only may it be found in the means adopted to render the section of the prostate permanent, but further, that something is due to the introduction into the prostate of no inconsiderable quantity of shrinking or cicatricial tissue. I see that Dr. Gouley[1] claims priority for the proceeding just described; what is of more importance is that it has received his approval.

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[1] Proceedings of the International Medical Congress of Copenhagen, 1884.

RUPTURE OF THE PROSTATE AND BLADDER.

An instructive case of extra-peritoneal rupture of the male bladder by crushing, has been reported by Dr. R. F. Weir.[2]

The patient having been etherized, an incision three and a half inches long was made under sublimate irrigation in the median line, midway between symphysis and umbilicus, until the subperitoneal plane was reached, where a large cavity was found containing at least a pint of bloody, undecomposed urine. The finger could be carried its full length behind the symphysis, but nothing was detected. To permit a more complete diagnosis, as well as to allow of the carrying, if possible, of a drainage-tube from the hypogastric opening down and out of the perineum, the patient was placed in the lithotomy position, and, on a staff introduced into the bladder, a median incision was made, opening the urethra just anterior to the prostate; the finger, passed in here towards the bladder, revealed a rent running along the left side of the roof of the prostate, which was lost in the wall of the bladder itself. Its upper limit was not defined, purposely, to avoid extra damage to the part. Through the supra-pubic incision a large silver catheter was carried, and, aided by the finger in the perineal wound, was caused to pass through the laceration of the bladder and to emerge from the lower wound. To the eye of this catheter a thread was attached, and a large rubber drainage-tube was pulled through as the silver instrument was withdrawn. Each end of the tube was secured by a suture to the skin, and a second drainage-tube was then passed into the bladder, and its external end also fastened in the perineum, The cavity which had contained the extravasated urine and the bladder were carefully washed out with a warm sublimate solution of 1 to 2000, and iodoform gauze was placed over each wound, though so lightly that urine could readily flow through the dressing. The patient made an excellent recovery.

This case illustrates not only the value of the perineal incision under such circumstances, but the importance of providing the most perfect kind of urine-drainage as a fundamental principle in the treatment of ruptures of the bladder. Additional prominence has been given to this point in Mr. Rivington's recent and important work.[3]

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[1] New York Medical Journal, May 2, 1885.

[2] Medical Record, March 29, 1884.

[3] Rupture of the Urinary Bladder, based on the Records of 300 cases. London, 1884.

INJURIES AND DISEASES OF THE URETHRA.

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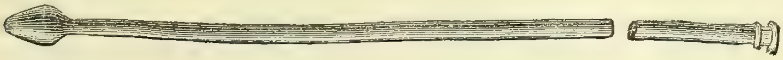
Exploration of the Urethra and Bladder.

Direct inspection of the genital organs and of the hypogastric region may inform us in regard to certain lesions of the urethra and bladder, such as vices of conformation, wounds, and fistulæ. In women this inspection demands the employment of the speculum, which exposes the vesico-vaginal septum and the posterior wall of the urethra. *Palpation* of the lower surface of the penis, or of the perineum, sometimes discloses the presence of lesions situated in the penile and perineal portions of the urethral canal (stricture, calculus); and, combined with *percussion*, makes it possible to estimate the state of distension or emptiness of the bladder. In the same category of methods of exploration, the *rectal* and *vaginal touch* must be noted. By the rectal touch the pulp of the forefinger, turned toward the prostate and the *bas-fond* of the bladder, can explore those parts of the urinary organs, and furnish important data for diagnosis. In women, the vaginal touch renders analogous service in permitting the finger to palpate the urethra and the *bas-fond* of the bladder. But it is chiefly by *sounding* that we succeed in acquiring the most precise notions in regard to the state of the organs in question. This exploratory sounding should be made in a different manner, and with special instruments, according as it is proposed to explore the bladder or the urethra.

Exploration of the urethra, which has for its principal object to ascertain the degree of permeability of the canal, and to detect the presence of an obstacle to normal micturition, is practised with the aid of flexible bougies (Fig. 1305) with bulbous extremities, of variable size and conical in form.

Fig. 1305.

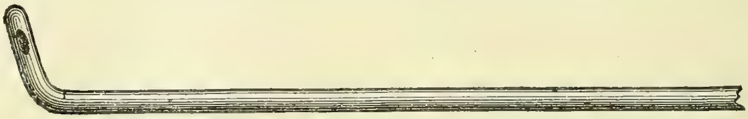


Exploratory bougie.

The introduction of this instrument is very easy. It suffices, after oiling it well, to insinuate it slowly into the meatus, when a gentle and continuous pressure will make it traverse the whole length of the urethra, if there be no obstruction. In the contrary case the instrument is arrested; and we shall see hereafter, in speaking of strictures of the urethra, how by this means one can determine exactly the seat, extent, and degree of the narrowing. The exploration of the urethra with the *bougie-à-boule* makes it possible, also, to recognize the degree of sensitiveness of the canal, and to determine at what points this sensitiveness exists.

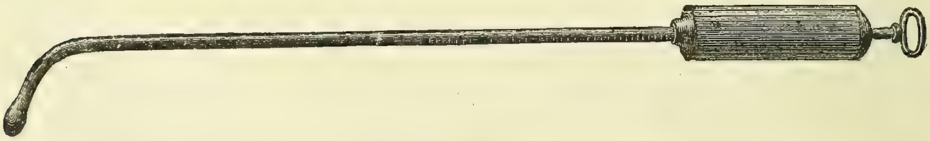
Exploration of the bladder requires the use of metallic instruments with a small curve. These instruments, generally of silver or German silver, are in the form of solid or hollow sounds (catheters), terminating in a short beak, 25 millimetres long, inclined at an angle of 13° more than a right angle with the shank, and slightly expanded at the end. (Fig. 1306.) Sir Henry Thompson has improved this instrument by giving it a cylindrical handle, which makes it possible to guide its movement in every direction, and insures a more accurate contact with the hand of the surgeon. (Fig. 1307.) Further, for exploration of the bladder, and especially in the case of foreign bodies, special instruments are employed, which are designated by the name of exploratory lithotrites. Of these we shall speak hereafter. They have the same form as the exploratory sounds with small curve, and their introduction into the bladder is governed by the same rules.

Fig. 1306.



Exploratory catheter.

Fig. 1307.

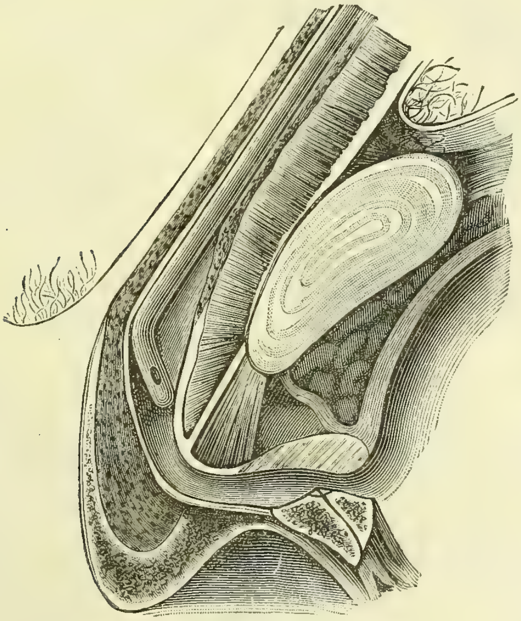


Thompson's catheter-sound.

Exploratory Sounding.—The patient should be laid upon a bed of suitable height, the pelvis resting in a horizontal position, or even slightly raised by means of a small pillow or a folded cloth several times doubled, the thighs separated, and the legs slightly flexed. Some surgeons still advise that every exploration of the bladder should be preceded by the injection of a certain quantity of lukewarm water. In most cases it is useless to have recourse to this preliminary operation, and it is enough that the bladder should contain a small quantity of urine for the exploration to be conducted under the best conditions. Should it be otherwise, the surgeon should proceed to this injection, after having previously introduced a flexible, rubber catheter, taking care to introduce the liquid very gently, and to stop before the patient complains of the desire to urinate, and as soon as the piston of the syringe used for the injection encounters the least resistance. The surgeon, placed at the right of the patient, takes the penis with the left hand between the middle and ring fingers, whilst the index and thumb roll the prepuce back and separate the lips of the meatus. The sound or catheter, previously coated with oil, is held in the right hand, the thumb lying across the side of the convexity of the instrument and close to the outer extremity, the index and the middle finger applied to the opposite side, so that the outer extremity rests upon the last phalanx of the index. Most authors advise holding the instrument parallel to the *linea alba.* Some prefer to incline its curvature toward the right inguinal region, giving it a direction parallel to the gluteal fold, and to insinuate it gently into the meatus; then as soon as it penetrates to the spongy portion of the urethra, to replace the sound and the penis parallel to the abdomen and the linea alba. But whatever may be the manner in which the introduction is begun, the manœuvre of exploratory sounding is comprised in three stages.

First Stage.—The sound is gently pressed into the urethra, at the same time that the surgeon presses the penis upon the sound. It is important that during its progress the instrument should be kept in the median line, the beak following the upper wall of the urethra, the heel resting on the posterior wall which it presses away. When the instrument so conducted reaches the *cul-de-sac* of the bulb, its extremity tends naturally to engage in the opening of the membranous portion, and the second stage begins. In order to regulate more precisely the precise moment when this second stage begins, Guyon has proposed the following modification of the classical procedure: He holds the sound in such a manner that its curve looks toward the inner face of the right thigh, the shaft and the handle being perpendicular to the anterior face of the thigh or even a little oblique. The sound being conducted in this way to the *cul-de-sac* of the bulb, arrives there in a transverse position, the heel resting on the left and the beak on the right lateral wall.

Fig. 1308.

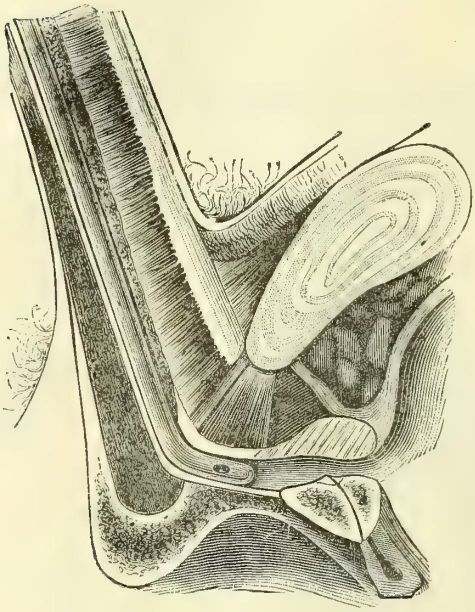


Exploratory sounding: first stage.

The arrest of the instrument indicates that it has reached this level and that the first stage is complete. In reality, in order that the beak shall penetrate the curved portion of the canal, it is indispensable that it shall go through half a revolution, in such a manner that its extremity shall follow the upper wall, its heel corresponding to the lower. As soon then as the surgeon feels the resistance which the floor of the bulb offers, he brings the penis and the instrument back gradually toward the median line of the abdomen, and it is seldom necessary even to give a slight movement of rotation to the handle of the sound in order that its beak shall engage in the membranous portion of the canal. Commonly this movement of the sound is executed spontaneously, and the surgeon should rather follow than direct the movement of the instrument.

Second Stage.—As soon as the beak of the instrument has penetrated the opening of the membranous portion, the handle tends to rock forward of itself. The hand of the surgeon has, so to speak, no other function than to follow this movement, supporting the sound gently and holding it in the median line. But the left hand, on the contrary, plays a very important part; abandoning the penis, it should be applied flat to the pubic region and made to depress strongly the soft parts which cover the pubis. The object of this movement is to depress and relax the suspensory ligament of the penis, and consequently to diminish the curve of the membranous portion of the urethra.

Fig. 1309.



Exploratory sounding: second stage.

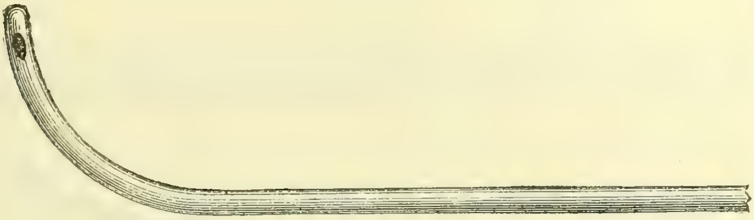
Third Stage.—In the normal state this third stage blends with the second stage, and is accomplished, so to speak, without the knowledge of the surgeon. The sound, continuing its movement of rocking forward, passes rapidly through the membranous and prostatic portions, and reaches the bladder. Only rarely is it necessary to aid this progression by a very light propulsion of the instrument. This third stage, so easy in the normal state, often presents the greatest difficulties in pathological cases, and requires certain special manœuvres which have been indicated in the article on diseases of the prostate. The fact that the instrument has reached the bladder is recognized when the instrument can be moved freely in all directions. At this moment the exploration of the urinary reservoir begins. The sound is gently pushed on until it touches the posterior wall, and then is brought forward after its beak has been successively inclined to the right and left. By these manœuvres the capacity of the bladder is ascertained, as well as the condition of its lateral walls, and the condition of the neck. To explore the lower wall and the *bas-fond*, the beak of the instrument is turned downward and drawn gently toward the neck of the bladder. Finally, the examination of the upper wall requires the lowering of the handle, which carries up the bent extremity of the instrument. By these various manœuvres one can not only acquire information as to the degree of sensitiveness of the organ, and as to the state of its walls, but may also recognize the presence of foreign bodies or calculi.

I shall limit myself to this simple general presentation, waiting until a future time to dwell upon the exploratory manœuvres appropriate to different cases. I shall only add that from the quantity of urine contained in the bladder, and from the force of the stream that flows from the catheter, it is possible to judge approximatively of the degree of contractility of the vesical walls.

As complementary to the study of exploratory sounding, I think I ought to indicate here briefly the rules for evacuatory catheterization, so as not to have to return to it hereafter.

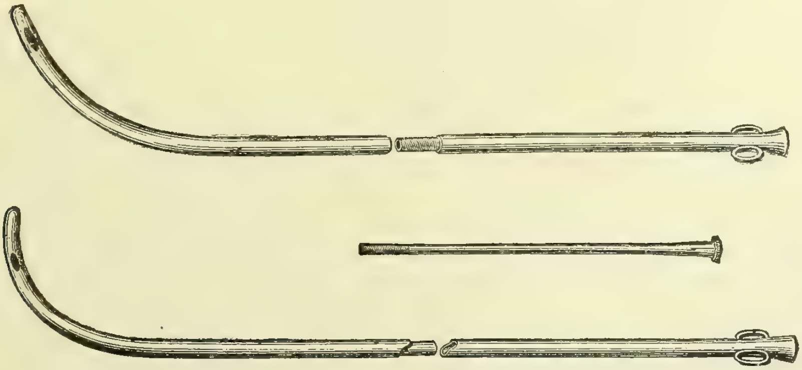
Evacuatory Catheterization.—The instruments used to empty the bladder of urine, are metallic and flexible catheters. The first are of silver or German silver; they have a length of 30 centimetres, and a diameter of 5 millimetres; their curve is very variable, and particular forms are specially suited for certain cases. The catheter most commonly used (Fig. 1310) has at its end a curve which forms a quarter of a circle, 8 or 9 centimetres in diameter; its handle is funnel-shaped, and bears at the sides two little rings, placed transversely, which may serve to fix it, and to indicate the position of the beak of the instrument. For the convenience of the surgeon, metallic catheters are made, composed of several pieces, so as to be taken apart and put in a pocket case. (Fig. 1311.) The so-called "gum catheters" are generally made of a silk tissue, which constitutes the framework of the instrument, and upon

Fig. 1310.



Ordinary catheter.

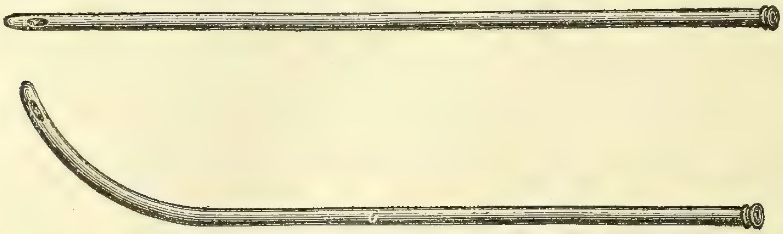
Fig. 1311.



Metallic catheter in sections.

which are wrapped a large number of layers of a mixture of linseed oil and liquefied caoutchouc. These catheters are straight or curved (Fig. 1312), and among the latter the curves vary. To this class belong also the elbowed and double-elbowed catheters. (Fig. 1313.)

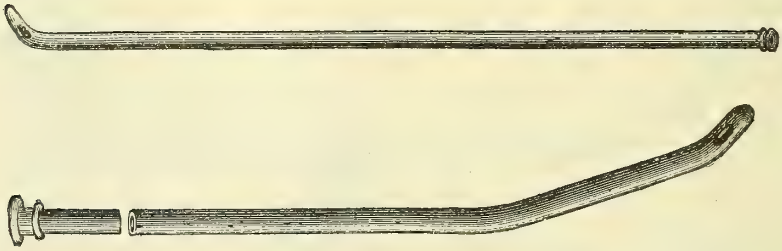
Fig. 1312.



Gum catheters, straight and curved.

In addition to cylindrical catheters, catheters with conical or olivary extremities are used in certain cases. Finally, for several years past catheters without the silk web, and made entirely of vulcanized caoutchouc, have been advantageously employed for evacuatory catheterization. On account of their extreme flexibility, these catheters run no risk of wounding the walls of the canal during their introduction, and they are very well borne by patients when allowed to remain. (Fig. 1314.)

Fig. 1313.



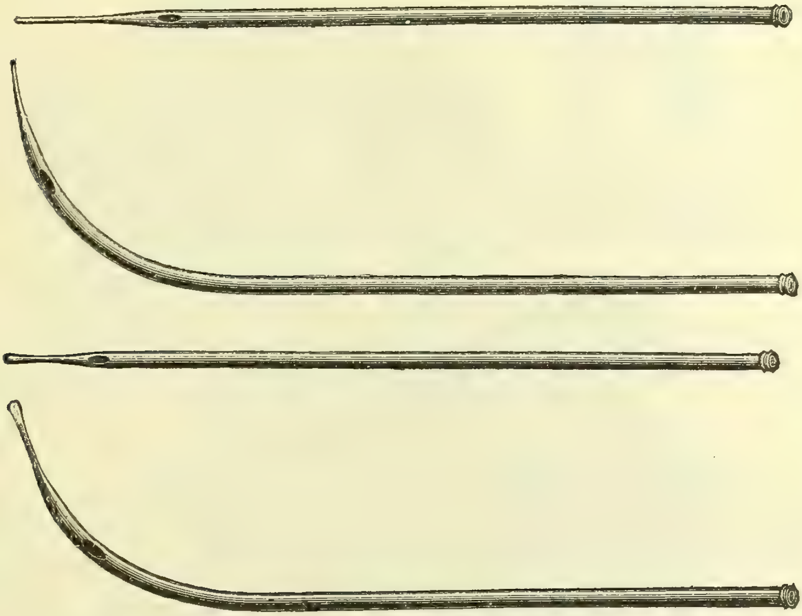
Elbowed catheters.

I will describe briefly the method of evacuatory catheterization with metallic and with flexible catheters.

Evacuatory Catheterization with Metallic Catheters.—Here we find again the three stages spoken of in connection with exploratory sounding. *First stage:* The patient lying down, as has been already described, the surgeon places himself at the left hand of the bed, and, holding the penis of the patient with the left hand and the catheter with his right, according to the rules already given, he brings the instrument in front of the abdomen, parallel to the linea alba, insinuates its extremity into the meatus urinarius, and makes it glide along the urethra, while at the same time he presses the penis gently upon the catheter. (Fig. 1315.) When the beak of the instrument arrives below the pubis, it is stopped by the neck of the bulb. The *second stage* then begins, and, in order that the instrument shall continue its course, it is necessary for it to be given a movement of rocking forward, during which its beak engages in the membranous portion of the urethra and traverses its whole length. The surgeon's part consists in following, so to speak, this change of direction, by gradually lowering the handle of the catheter between the thighs of the patient, and by exercising a very light pressure upon the instrument.

Under normal conditions, the *third stage* of catheterization with a curved instrument blends with the second, of which it is the uninterrupted continuation. So it is sufficient, under these conditions, to continue the rocking movement and the propulsion, in order to cause the catheter to pass through the prostatic portion of the urethra and to make it enter the bladder.

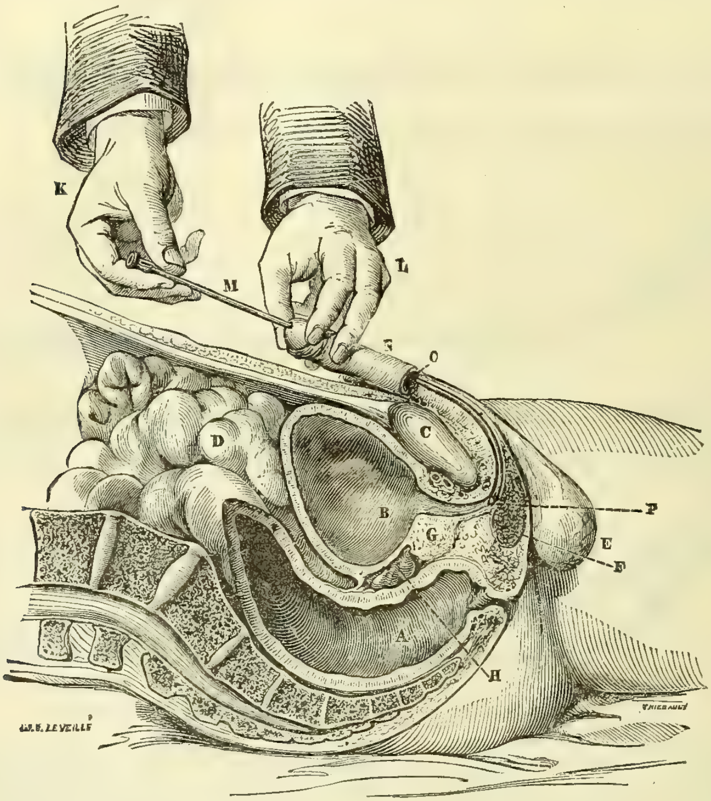
Fig. 1314.



Gum catheters, straight and curved, with conical and olive-shaped ends.

The most delicate stage of catheterization with a curved instrument corresponds with the passage of the catheter through the curved portion of the canal; so that it may not be useless to point out just here the difficulties most frequently met with, and the way to overcome them. We shall return hereafter to special cases. It may happen that, at the moment when the handle of the catheter is lowered, its beak, having pressed the bulb too far down, pushes before it the walls of the canal, the opening of which is thus closed. In such a case the instrument must be withdrawn a little, and the rocking movement be begun again. At the same time the left hand is set free, as it is no longer needed to support the penis, and it may be used to aid in this manœuvre. It is to be placed under the scrotum, and the fingers, pressing on the convexity of the catheter through the perineum, furnish a point of support upon which it turns as on a pivot at the moment when the handle is lowered, so that its beak is elevated and enters the curved portion of the canal. (Fig. 1316.) In persons with considerable fat, it not rarely happens that at the moment when the catheter is lowered it is caught against the upper wall of the canal and stopped. In such a case the manœuvre spoken of in connection with exploratory sounding, and which consists in pressing the soft parts of the pubes firmly down so as to relax the suspensory ligament of the penis, will make it easy to engage the beak of the catheter. Finally, when the instrument is stopped in the prostatic portion of the urethra, the rectal touch will come to our aid. The finger inserted in the rectum supports the catheter, keeps its beak applied against the upper wall, and so permits it to pass over the obstacle.

Fig. 1315.

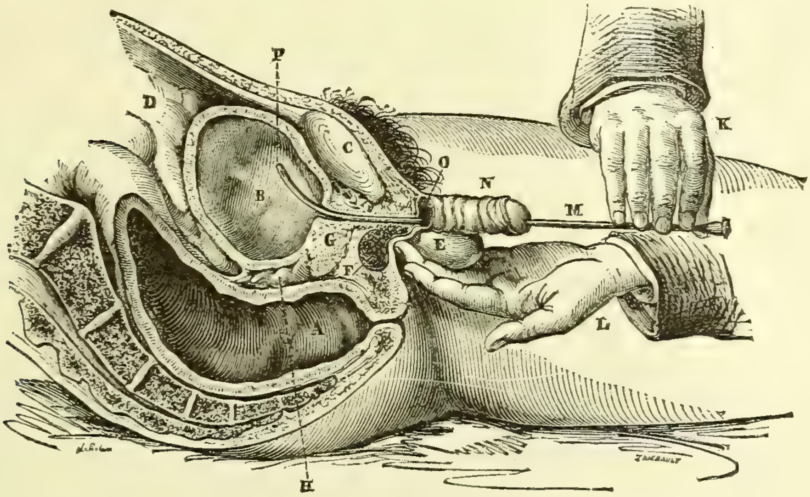


Evacuatory catheterization: first stage.

Evacuatory Catheterization with Flexible Catheters.—Catheterization with flexible catheters is practised in two totally different ways: sometimes the catheter is used by itself, sometimes there is introduced into it a more or less flexible metallic rod, called a stylet (Fig. 1317), which is designed to give the catheter the qualities of an inflexible instrument. The flexibility of the stylet makes it possible also to bend it at will, and thus to imitate all the varieties of metallic catheter. A stylet should become as it were one piece with the catheter. To secure this fundamental condition, Voillemier recommends the use of stylets the heels of which are conical for a distance of three or four centimetres, and which enter the catheter with some friction.

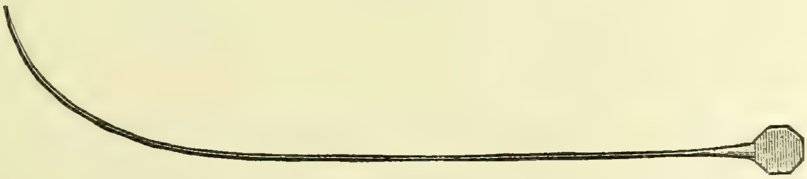
The various manœuvres of catheterization with flexible catheters armed with stylets, do not differ from those which I have already described for evacuatory catheterization with curved metallic catheters. I need not go over this again, but I ought to point out a special manœuvre which makes it possible to employ a stylet with an elbow, and which may be of service in cases of prostatic obstruction. This manœuvre consists in drawing the stylet back, at the same time that the catheter is pushed on, so that the beak of the latter rises up and undergoes a change of direction which allows it to pass over the obstacle. Guyon recommends for this manœuvre the employment of a double-elbowed catheter, the movement of which, when it is liberated by the withdrawal of the stylet, furnishes the conditions which are needed for overcoming prostatic obstruction much better than the ordinary elbowed catheter.

Fig. 1316.



Evacuatory catheterization: third stage.

Fig. 1317.



Stylet.

Catheterization with a flexible catheter, not armed with a stylet, does not merit special description. The flexibility of the instrument causes it to accommodate itself to the various curves of the canal, and it suffices to push it on gently, to make it traverse the whole length of the urethra. Meanwhile, an exact knowledge of the normal anatomy of the part, and the dexterity which practice alone can give, enable one to stop before an obstacle, to pass round it, or to avoid it by directing the catheter in one direction or another.

To complete what refers to the general rules for catheterization, I shall say a few words about catheterization in the female, and about the manner of fixing catheters which are to be retained.

Catheterization in the Female.—For this catheterization, which is generally very easy on account of the shortness and the almost rectilinear direction of the canal, either metallic catheters, very slightly curved, or ordinary flexible catheters are used. The patient lies upon the back, the pelvis being elevated with a folded cloth, the thighs separated, and the legs slightly flexed. The surgeon, placed at the right of the bed, separates the labia with the thumb and index of the left hand, and exposes the meatus urinarius, which is situated below the clitoris, a little above the opening of the vagina. He then introduces the catheter into the meatus in such a manner that its concavity is turned toward the pubis, and, pushing the instrument gently forward at the same time that he depresses it lightly between the thighs, he makes it pass on into the bladder.

It may be useful to know how to pass the catheter on women without exposing them. The following is the procedure to be carried out with this object: The patient lying down in the manner just described, the surgeon places his left hand in a position of pronation before the vulva. With the thumb and the middle finger he separates the labia majora and minora; then he carries the forefinger to the entrance of the vagina and draws it gently forward until he feels in the median line a little depression, which is nothing else but the entrance to the urethra. He keeps his finger at this point, and passes the beak of the catheter along its pulp and introduces it into the canal. This procedure, the description of which I borrow from Voillemier, is preferable to that which consists in first recognizing the clitoris with the left forefinger, and using this organ as a guide to find the orifice of the urethra.

Method of fixing a Catheter in the Urethra.—There are cases, to be considered hereafter, in which it is necessary to allow a catheter to remain for some time in the bladder; and to accomplish this various contrivances have been devised to keep the instrument in place. The majority of these have fallen into oblivion, and nowadays recourse is hardly ever had to anything but very simple means which the surgeon applies himself. That most commonly used consists of two cords, composed of several strands of cotton thread, which are knotted at their middle upon the catheter, about a centimetre from the meatus. The four ends of the cord are carried along the penis, one on each side, one on the upper aspect, and one on the lower aspect, and are attached by a strip of adhesive plaster carried two or three times around the penis. After this it is important to double the ends of the cord back over the strip of plaster, and they may even be rolled round the penis, the fixation being finished with a final turn of the strip.

ENDOSCOPY.—I cannot conclude these remarks about exploration of the urinary organs, without calling attention to the efforts which have been made to carry light into the depths of those organs, and to recognize with the eye the alterations of which they may be the seat. The more or less complicated forms of apparatus devised for this object, and especially the endoscope of Désormeaux, are quite difficult to use, and, up to the present time, have given results of no great value. So I confine myself to mentioning, without describing them.

TRAUMATIC LESIONS OF THE URETHRA.

Among traumatic lesions of the urethra some are produced from without inwards, others from within outwards; the latter follow the introduction of foreign bodies into the urethral cavity, or are the consequence more especially of clumsy surgical manœuvres (false passages).

TRAUMATIC LESIONS OF THE URETHRA PRODUCED FROM WITHOUT INWARDS.—These lesions comprise: (1), wounds, properly so called, made by puncturing or cutting instruments; and (2), contusions and contused wounds, which are oftener designated by the name of ruptures or lacerations of the urethra, when they are not accompanied by solution of continuity of the peri-urethral soft parts.

I. Wounds of the Urethra.—On account of its situation, the urethra escapes rather easily the action of puncturing or cutting instruments. Protected at the back by the whole thickness of the perineum and by the pubes, it is seen to be imbedded in front in the trough presented by the cavernous bodies at their lower part; whence it results that, even if the urethra alone could be wounded in its perineal portion, this could happen only very rarely in its free portion, without the existence of a concomitant wound of the cavernous bodies.

Punctures of the urethra are without consequence. They are usually accompanied by a slight flow of blood from the meatus, or by an ecchymosis situated at the point where the instrument has penetrated, and they heal spontaneously at the end of a few days. Wounds made with *cutting instruments* are more serious, and their gravity varies with their extent and seat. Those of the *perineal portion* of the urethra are extremely rare, are characterized by a more or less abundant escape of urine, and heal spontaneously with extreme rapidity—of which an idea may be formed by observing the way in which wounds resulting from perineal lithotomy behave. In order, however, to prevent a possible infiltration of urine in cases of this sort, a catheter should be introduced and retained, and the wound should not be closed with points of suture, but merely covered with a simple dressing.

Wounds of the *pendulous portion* of the urethra are accompanied, however small they may be, by a solution of continuity of the cavernous bodies, and consequently by an abundant but not serious hemorrhage, which stops spontaneously, or upon light compression. The *treatment* consists in the introduction and retention of a catheter, preferably a cylindrical one if the urethra has not been divided through its whole circumference. If, on the contrary, the extent of the wound leads to the fear that a complete division of the canal has taken place, it is preferable, because of the retraction of the two edges, to employ a catheter with a conical or olivary end, the extremity of which, at once delicate and blunt, meets with less obstruction. When the catheter is once in place, the wound should be sutured either with close interrupted sutures, or, better, with the continuous suture. At the end of the second or third day the catheter must be removed, for fear that it may give rise to suppuration, which would prevent immediate union. If it should prove impossible to pass the catheter through the posterior edge of the cut, it might be well, as Voillemier has recommended and as Reybard has successfully practised, to suture the wound notwithstanding, but then to watch the micturition with the greatest care, removing the sutures at the first sign of infiltration. In case the cavernous bodies have been divided through the greater part of their extent, the conduct of the surgeon should be the same. It should be remembered, moreover, that every transverse wound of the urethra, even the simplest, inevitably leaves behind a cicatricial stricture, often most rebellious to treatment.

II. Contused Wounds; Ruptures and Lacerations.—There are two varieties of contused wound of the urethra. In the first, which I shall simply mention, and the type of which is seen in gunshot wounds, the solution of continuity involves not only the urethra but also the soft parts which cover it. In the second, to which alone the name of rupture or laceration is applicable, solution of continuity, complete or incomplete, of the urethra exists alone without wound of the soft parts.

Etiology.—Ruptures of the pendulous portion of the urethra are rare, while on the contrary those of the bulbous and membranous portions are very frequent. In regard to their cause and their mechanism, they differ in different cases.

(1) *Rupture of the Pendulous Portion.*—Very rarely rupture of the pendulous portion is caused by direct violence, the penis being in a state of repose. Of this there are a number of examples. Voillemier cites the case of a man whose urethra was ruptured by the kick of a horse; and there is found in the thesis of Bollard an account of a man sixty years old, who was knocked down by a heavy wagon, the wheel of which passed across the upper part of his thighs, bruising the penis at its root, near the pubis. In each of these two cases it was upon the pubis that the urethra was pressed and lacerated. In the following case, likewise reported by Voillemier, the penis was caught between two hard bodies: a *valet de chambre*, wishing to close the drawer of his bureau, pushed it with the upper part of his thighs so that unfortunately his penis, then hanging down, was violently squeezed, and he sustained a rupture of the urethra. Somewhat more frequently, a direct contusion has torn the urethra when the penis has been in erection. Such an accident happened to a man spoken of by Voillemier, who, in a house of prostitution, received upon the erected penis, just in front of the scrotum, a blow from a pair of tongs, which ruptured his urethra without involving the skin. During erection, rupture of the urethra may be effected by another mechanism: by torsion or by exaggeration of the curve of the penis. This sometimes produces a rupture including at the same time the spongy body and the cavernous bodies—what is called a fracture of the penis. Sometimes the urethra alone is lacerated on one of its sides. The commonest cause of this sort of rupture is the accomplishment of coitus under certain conditions: either, as Demarquay remarks, it is the consequence of a violent effort at intromission, or it occurs during the act of coitus, when a false movement produces a rough flexion of the penis against the pubis or perineum of the female. In other cases, of which some examples have likewise been observed, the laceration takes place in consequence of a rough and energetic twisting of the penis with the hand.

I will mention finally, as a frequent cause of the accident which we are studying, the absurd practice of certain individuals suffering with chordee following acute urethritis; this consists in "breaking the cord," that is to say, in placing the penis on a table and striking it on the dorsal surface with the fist.

(2) *Rupture of the Perineal Portion.*—The traumatisms which affect the perineal portion may be ranged under two principal types: either the individual has a fall upon the perineum, or a blow or other violence is applied to the perineal region. Examples of the first variety are numerous, and consist almost altogether of falls across bodies of different sorts, a beam of wood, a plank, a spar of a ship, etc. Ruptures following blows on the perineum are much more rare; their commonest cause is a kick upon the perineum by a man or a horse, when the thighs are separated, as upon the perineum protruding backward while the body is inclined forward. The mechanism of these ruptures has long engaged the attention of authors, who have expressed in regard to this subject contradictory opinions. According to Velpeau and Franc, the urethral lesion was the result of a crushing of the membranous portion of the urethra against the lower border of the pubic arch, or of its bulbous portion against the anterior surface of the pubis, and this opinion, repeated by all authors, has long been accepted without contest. It has, however, been combated by Cras, who, in a paper which appeared in 1876,

attempted to establish a new theory. According to him, the urethra, fixed by the triangular ligament about two centimetres from the lower border of the symphysis, could not possibly be crushed against it; it could at best only be compressed against the face of the pubis, which, in the erect position, makes an angle of from 30° to 35° with the horizon, but this would be a rare mechanism. According to Cras, the contusing force scarcely ever comes directly upon the median line of the perineum; it acts most frequently upon one of its sides, forcing the urethra away laterally, so that the latter is squeezed between the contusing body and the highest portion of the descending ramus of the os pubis. There exists at this point a sharp ridge, which can be felt through the skin, and which rises several millimetres above a plane resting on the anterior face of the symphysis.

On the other hand, A. Poncet, of Lyons,[1] concludes from investigations made upon the cadaver with Ollier, that the theory of Velpeau (crushing against the pubis) is applicable to lacerations of the bulbous portion of the urethra. As to lacerations of the membranous portion, they are the result of a true section of the canal against the sharp edge of a special ligament (the transverse ligament of Henle), a kind of fibrous bridle with an acute edge, slightly concave, extending transversely between the two descending portions of the pubis, the height of which is from 10 to 12 millimetres. The urethra, in the experiments of Ollier and Poncet, was found to be divided at this level, but only at the expense of its upper wall. We shall see that this fact is in formal contradiction to the results of many autopsies.

Finally, quite recently, Terrillon taking up in turn this question, has arrived at the following conclusions, likewise based on experiments on the cadaver. (1) Falling astride upon a narrow body, easily capable of being included in the sub-pubic angle, causes rupture of the urethra according to the mechanism pointed out by Cras (crushing of the urethra upon the sharp edge of the ischio-pubic ramus), and the rupture is situated at the middle portion of the bulb, on the lower lateral wall of the canal. (2) When a fall takes place astride on a voluminous body, which is with difficulty included under the pubic arch, the urethra is crushed against the anterior face of the pubis, or even against the lower edge of this bone, and the rupture is situated in the anterior portion of the bulb, or in the spongy body, and involves the lower wall of the canal. Blows on the perineum produce results analogous to the preceding.

(3) *Rupture of the Urethra by Fracture of the Pubis.*—It can be easily conceived that the urethra, which is separated from the pubis by a distance which never exceeds fifteen or twenty millimetres, may be subjected to more or less considerable injury in consequence of a fracture of the bone, and even a slight displacement of one of the fragments. It can be conceived equally well that, while the spongy, the bulbous, and even the prostatic portion, which has a certain mobility, escape rather easily the action of the contusing body, the membranous portion, fixed by the triangular ligament, cannot evade it. Experience demonstrates, in fact, that it is most frequently this membranous portion which is injured by the lower border of the displaced bone. It is certain, however, that in a large number of fractures of the pubis, the rupture of the urethra is produced by a different mechanism: I refer to rupture "by traction"—by displacement of the urethral walls, held fast by aponeuroses. A fragment of the pubic bone, breaking in from the side of the pelvis, drags with it the triangular ligament, which drags upon the wall of the urethra, and tears it. Finally, fracture of the pelvis may, by still another mechanism,

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[1] Note sur le siége précis des ruptures de l'urèthre et sur leur méchanisme. Lyon Médical, p. 709. 1871.

produce, not a rupture of the urethra, but a veritable contused wound of the urethral wall: a scale of bone, more or less pointed, is detached from the rest of the bone, and impinges against and directly perforates the urethra.

I ought here to allude to a possible source of confusion: in certain cases of contusion of the perineum, a more or less extensive fracture of the pubic bone is produced at the same time with the rupture of the urethra. Here the fracture is secondary, and has nothing to do with the mechanism of the urethral rupture.

Laceration of the urethra may even be produced without fracture of the pubic bone, a simple dislocation at the symphysis having caused an overriding of the two bones. It might even happen that this dislocation was only momentary, the bones returning to their normal position, and the rupture of the urethra remaining the sole evidence of this lesion of the pelvis. In certain examples of individuals caught under falling earth, etc., especially in a case reported by Voillemier, the rupture of the urethra could only have occurred in this way, and the same mechanism seems to me to be applicable to a case of Sir Henry Thompson's, in which a fall vertically upon the feet was accompanied by a rupture of the urethra, which the author endeavors to explain by muscular action. This same muscular action has been invoked by the authors of the "Dictionnaire des Sciences Médicales," in two cases of rupture of the urethra observed at the Hôtel-Dieu, which were probably due to either simple dislocation or unrecognized fracture of the pelvis.

Pathological Anatomy.—Rupture of the urethra does not always extend through the whole thickness of the walls of the canal, so that in this lesion several degrees may be admitted, viz: (1) interstitial rupture; (2) rupture of the mucous membrane and of the subjacent tissue; (3) total rupture of the wall of the urethra, complete or incomplete, according as it involves the whole or a part of the circumference of the canal. This division into degrees is, however, applicable only to ruptures of the spongy portion of the urethra, the only one of which the walls include three tunics: an external or fibrous tunic; a middle tunic, made up of the spongy tissue; and, finally, an internal tunic, composed of the mucous membrane and the submucous tissue.

(1) *Interstitial rupture.*—This variety of rupture, in which the spongy tissue alone is involved, whilst the mucous membrane and the exterior fibrous envelope escape injury, is produced with extreme facility, and under the influence of a contusion which, in any other part of the body, would pass unperceived. Reybard seems to me to have given the most rational explanation of this special friability of the spongy tissue. The trabeculæ of this tissue fix bounds to the vacuoles containing blood, and, under the influence of a momentary blow, this incompressible fluid tends to escape in every direction, and so bursts asunder the walls of these vacuoles. In consequence of interstitial rupture, a pocket containing blood is formed at the point of contusion, limited posteriorly and anteriorly by the spongy tissue which remains intact, externally by the inextensible fibrous envelope, and internally by the mucous membrane, which is pressed in toward the cavity of the urethra, and thus produces a kind of acute stricture of this canal.

(2) In the second degree, there exists a *rupture of the mucous membrane and of the submucous tissue*, which is always accompanied by an interstitial rupture. Sometimes the mucous membrane is barely frayed at one or more points, but more frequently the rupture of the latter makes a communication between the sanguineous interstitial pocket and the cavity of the urethra; from which result, on the one hand, the passage of blood into the urethra and its escape externally, and, on the other hand, the more or less ready entrance of urine to the focus of the rupture. Only rarely, in this degree of rupture, is the mucous membrane torn through its whole circumference. Cras, however, cites an

example in which he found, in consequence of the patient falling astride, a complete rupture of the mucous membrane at the level of the middle portion of the bulb. In case of incomplete rupture of the mucous membrane, it is the lower wall which is oftenest injured.

(3) In the third degree, there is a simultaneous *rupture of the mucous membrane, of the spongy tissue, and of the fibrous membrane which surrounds it.* The laceration is transverse; all the layers of the wall are broken at the same level, whence results a communication of the cavity of the urethra with the tissues of the perineum. But in this degree two perfectly distinct varieties may be recognized; the rupture is incomplete or complete. *Incomplete rupture* occupies only a part of the circumference of the urethra. Rarely the lesion is reduced to a simple perforation; most frequently the walls are extensively lacerated, but there remains a tongue of sound tissue joining the two ends, generally situated in the upper wall, and of great importance, whether as regards the possibility of catheterization, or as regards an operation to search for the posterior end. In consequence of the elasticity of the wall of the urethra, the edges of the solution of continuity separate, leaving between them a gaping wound, more or less filled up with accumulated clots. When the rupture is *complete*, the canal is divided transversely; the two ends, one posterior, the other anterior, are retracted, and separated by a distance which may vary from two to four centimetres; sometimes they are even placed laterally in regard to one another. Between them there is a cavity filled with clots, which communicates with the soft parts of the perineum, and which afterwards will contain a mixture of pus, urine, and blood. The edges of the urethra, comprising the mucous membrane and the spongy body, form the anterior and posterior limits of the cavity. The spongy body, divided transversely, presents an irregular, jagged surface, which, examined under a stream of water, is seen to be covered with many filaments and with tufts, which are simply the trabeculæ affected by the traumatism. The mucous membrane, curled up, wrinkled, and often hard to recognize, sometimes interposes a momentary obstacle to the passage of a catheter. In some cases the mucous membrane of the canal may be detached—dissected off, so to speak—and may be freely movable by its anterior extremity, and for a certain distance, in the focus of the rupture.

In the *membranous portion* of the urethra the rupture is most frequently total, on account of the thinness of the walls and the feeble resistance of the surrounding muscles. It is only in altogether exceptional cases that the mucous membrane is simply frayed or split. Further, rupture here may similarly be complete or incomplete in regard to the circumference of the urethra. If there be a fracture of the pelvis, the displaced fragment may drag with it one of the divided edges of the urethra, and may thus produce a lateral displacement of the two ends such as I have already mentioned, and which will make especially difficult the search for the posterior segment.

Complete rupture of the *penile portion of the urethra* is extremely rare. The fibrous tunic resists, as is explained by the very nature of the mechanism which determines the rupture, and which is almost never that of contusion. In the majority of cases the lesion consists of a rupture of the mucous membrane, and of a certain area of subjacent spongy tissue.

Seat of Rupture.—In the penile portion of the urethra the seat of rupture corresponds to the point at which the rupturing force is applied, and its exact delimitation is of little importance. It is quite otherwise in regard to the perineal portion. This question of the seat of the lesion in ruptures of the urethra has been much discussed. According to Franc and Reybard, a rupture resulting from a contusion of the perineum is most frequently situated in the portion of the urethra which extends between the triangular ligament and the suspensory ligament of the penis. This, however, is too vague an assertion, and we have a right to demand greater precision in delimitation of the seat of rupture. From researches founded on information gathered at autopsies, and examinations made at the moment when perineal incisions had been practised, Cras came to the following conclusion: every time that the examination was made carefully, the bulbous region was found involved. Guyon, in his report on the paper of Cras, adopts the same opinion. Finally, Terrillon, relying upon the results of autopsies, upon explorations carried out by surgeons during operations of urethrotomy, and upon his own experience, arrives at altogether analogous conclusions.

In contusions of the perineum, ruptures are situated most frequently at the level of the middle or anterior portion of the bulb. There always remains, in front of the triangular ligament, a strip of the canal, having a length which varies from one to three centimetres. Ruptures of the membranous portion are almost constantly accompanied by fractures or dislocations of the pelvis. Those of the prostatic region are absolutely exceptional.

Extent of Rupture.—Recognition of the extent of a rupture is still more interesting than that of its seat. Is the rupture complete or incomplete? What wall has escaped the traumatism? These two questions are of capital importance in regard to treatment, in regard both to the introduction of a catheter and to the search for the posterior end of the divided urethra. Yet we find only uncertain data in the books in regard to the relative frequency of the lesion concerned. According to Terrillon, whose opinion is, however, only hypothetically advanced, complete ruptures should be most frequent in the membranous region, and altogether exceptional in the penile region. In regard to the seat of incomplete ruptures, it is admitted that they occupy the lower wall. Ollier alone, relying on the observations which I have already mentioned, maintains a contrary opinion. He maintains that the rupture takes place at the expense of the upper wall.

Lesions of the Parts adjacent to the Urethra.—In the perineum these are chiefly subcutaneous or sub-aponeurotic separations, accompanied by more or less abundant effusions of blood. Most frequently these foci do not communicate with the urethral lesion. At other times they do communicate with it, whence results the formation in their cavity of a mixture of blood, urine, and pus. Sometimes the triangular ligament is torn, or rather is separated from its lateral attachments, the effusion of blood extending into the iliac fossæ. In some cases, a laceration of the subpubic ligament has been observed. Likewise a separation of the root of a cavernous body has been noted, and this has been found torn away at the point of its ischio-pubic insertion. According to the observation of Terrillon, the tissue of the cavernous bodies is often burst and lacerated, but the lesion passes unperceived because of the persistence of the fibrous envelope, which possesses considerable power of resistance. Quite frequently rupture of the urethra is accompanied by a fracture of the pubis. In such cases, sometimes, as we have seen before, the fracture is primary and the urethral lesion is secondary; sometimes, on the contrary, the urethral lesion precedes the fracture. However this may be, two cases may present themselves: either the rupture of the urethra communicates with the point of fracture, or, on the contrary, this communication is wanting. In the first condition there may be danger of osteo-myelitis, and serious results; in the second, there is only a simple fracture, which behaves in the usual way. Finally, complications involving the integuments may occur. Sometimes there is a contused wound of the skin and subcutaneous tissue, not communicating with the rupture of the urethra; sometimes the contused wound involves the perineum throughout its whole thickness, reaches the urethra, and communicates with it. In the penile region the only neighboring lesion worthy of being mentioned is rupture of one or other of the cavernous bodies.

Symptomatology.—The principal symptoms of rupture of the urethra are three in number: pain, disorders of micturition, and hemorrhage from the urethra.

Pain is rarely absent, but is of very variable intensity in different cases. Sometimes so slight as to permit the patient to walk about and continue his work, in other cases it is so severe as to cause syncope. It has its greatest intensity at the point of injury, and thence it radiates to the neighboring parts. Further, it is soon replaced by a painful and agonizing sensation, which results from the passage of urine and the efforts of the patient to expel it, and which, at first intermittent, becomes continuous, and ends by disappearing.

Troubles of micturition are, so to speak, constant, but are variable, like other symptoms. Sometimes retention of urine is complete and manifests itself at the outset; sometimes the patient still manages to void a small quantity of urine, and the retention does not become complete until the end of several hours, or even after one or two days. Finally, after a temporary retention of urine, micturition may be re-established. In certain light cases the emission of urine continues, but is painful. If the lesion be a little more serious, the stream is small, and requires considerable effort on the part of the patient. At times there is incomplete or intermittent retention. It may be asked, What causes these variations? Retention may be explained, in interstitial rupture, by the protrusion of the hemorrhagic protuberance, which obliterates the lumen of the canal; in complete rupture, by the separation of the ends and the crumpling of the mucous membrane. Besides, the clots accumulated at the point of rupture may oppose a temporary obstacle to micturition, and afterwards the urine may resume its flow in consequence of the displacement of the clots. Finally, there is joined to these causes often, if not always, spasm of the membranous portion of the urethra, a temporary phenomenon which appears to be the principal, and, in cases which are not very grave, the only cause of retention in the first hours which follow the injury. Afterwards, at the end of a day or two, retention may be caused by inflammatory swelling, which acts by diminishing the calibre of the urethra and provoking flattening of its walls. The absence of these diverse causes explains the relative facility of micturition which is observed in certain cases, in which only a small portion of the mucous membrane has been involved.

Hemorrhage from the urethra is seen only in cases in which there is a solution of continuity of the mucous membrane, the blood coming then from the more or less lacerated spongy body. Ordinarily it appears immediately after the accident, sometimes in the shape of a few drops of blood, sometimes in the shape of a continuous oozing; sometimes, finally, it constitutes a true hemorrhage which may last quite a long time, and may even, in exceptional cases, cause death. Sometimes hemorrhage from the urethra does not occur until the end of several days. This is when an interstitial rupture has taken place, the mucous membrane, intact at first, sloughing consecutively or being torn by the introduction of a catheter. By direct examination of the parts there is often found an ecchymosis of varying intensity, proportionate to the depth and extent of the rupture, and especially proportionate to the seat of the contusion or the nature of the traumatism. Contusion of the perineum, for example, often causes, and sometimes very quickly, a very extensive ecchymosis. On the other hand, this is absent or appears only at a late period in ruptures which follow a fracture of the pelvis.

This is not all. Rupture of the urethra in the perineal region, especially in grave cases, is often accompanied by the formation of a tumor, usually situated in the median line, varying from the size of a pigeon's egg to that of a hen's egg, and capable of acquiring afterwards dimensions much more considerable. This tumor is sometimes susceptible to partial diminution by pressure, which causes the escape by the meatus of pure blood, which is afterwards mingled with urine. I have seen, in a case of this sort, the patient empty the pocket by pressure, and in an intermittent way, and thus prevent too prolonged stagnation of the urine and blood. Rupture in the penile region may likewise be accompanied by a swelling, generally of slight dimensions, forming only a nodosity, a kind of collar, which surrounds the canal for a certain distance.

Course; Complications; Termination.—The severity of the phenomena which follow rupture of the urethra varies with the degree of the primary lesion. In interstitial rupture, the sanguineous tumor resulting from the contusion may be absorbed spontaneously; but quite often it becomes inflamed, suppurates, and gives rise to an abscess, which opens either into the urethra or externally, or by both these ways at once. In rupture of the second degree, if the solution of continuity of the mucous membrane be very limited, things may turn out as in the preceding case, and resolution may take place without mishap. But if the wound of the mucous membrane be at all extensive, at each micturition a small quantity of the urine penetrates the subjacent lesion. This becomes inflamed and suppurates, the fibrous coat of the spongy body is rapidly destroyed, and the pus invades all the tissues of the perineum. Finally, in complete rupture, the secondary lesions always assume an extreme gravity. After an absolute but temporary retention, sometimes the urine flows in abundance, the patient urinates, so to speak, into his cellular tissue, and there results an extensive infiltration of urine with all its consequences; sometimes the bladder allows only a small quantity of urine to escape, this penetrating the bloody pocket between the two edges, and a urinary abscess following. In either the one case or the other, the skin sloughs at one or more points, and the result is the formation of a variable number of fistulæ, which give exit at first to a mixture of urine and pus, and afterwards to urine alone.

The anterior part of the divided urethra is constricted more and more by the contraction of the peri-urethral tissues, and in some cases even its complete obliteration has been noted. In regard to the intermediate space resulting from the separation of the two sections of the canal, it shrinks gradually, and becomes organized into fibrous tissue.

It is not possible to insist strongly enough upon this ultimate consequence, common to all ruptures of the urethra, to whatever variety they may belong —I mean the establishment of a stricture. This complication appears even in the case of interstitial rupture. The effusion of blood, in the process of absorption, causes induration and contraction of the spongy tissue. In this way there is formed a more or less complete collar, producing a coarctation all the more marked as it embraces a greater portion of the circumference of the canal.

Ruptures of the second and third degree are accompanied by the formation of a true cicatrix, leading to a fibrous stricture. In cases in which only a portion of the circumference of the urethra has been injured, the stricture assumes the form of a bridle, or a half-ring rising from the side of the canal. If, on the contrary, the rupture has been complete, the two ends separate, and the strictured part is made up entirely of newly formed tissue. The track which passes through this tissue is most frequently filiform, twisted, anfractuous, and always destitute of mucous membrane. It is to this variety of very tight, resistant stricture, that the name of cicatricial contraction has been given. We shall return to it hereafter.

Diagnosis.—The diagnosis of rupture of the urethra is generally easy enough to establish. Great importance should be attached to the history, and every victim of accidents such as I have indicated, should be suspected of having a rupture of the urethra, especially if he present one or several of the symptoms which characterize this lesion: hemorrhage from the urethra, retention of urine, perineal tumor. One may hesitate sometimes between an interstitial rupture, without laceration of the mucous membrane and consequently without hemorrhage, and a simple contusion of the perineum, especially as the latter is sometimes accompanied by retention of urine of spasmodic origin. In such a case the diagnosis must be reserved.

When once the fact of a rupture is established, it is important to determine its location. The point in the course of the canal where gentle pressure causes the greatest pain, and the presence of an ecchymosis at this point, often furnish a satisfactory notion in regard to this, especially in cases in which the contusion has been rather limited. On the other hand, direct exploration, practised with the *bougie-à-boule*, permits of recognizing, with great precision, both the exact location of the rupture and the point at which the focus of an interstitial rupture has thrust away the mucous membrane and effaced the calibre of the urethra. Unfortunately, the introduction of a catheter often has its dangers, and it should always be practised, therefore, with extreme gentleness.

In cases of complete rupture, the symptoms are so well marked that the diagnosis of the lesion, so to speak, establishes itself. I should add that the results of autopsies and of experiments made on the cadaver, make it possible nowadays to infer almost with certainty, from the cause of a rupture, its exact location. Thus it is proper to conclude that, in every case in which a contusion of the perineum causes a rupture of the urethra, this rupture is situated in the bulbar portion of the canal; and that in all ruptures of the urethra which follow a fracture of the pelvis, the membranous portion alone is involved. Nevertheless, after a fracture of the pelvis, it is not always easy to know whether there is a rupture of the urethra, or a laceration of the bladder in the vicinity of its neck. Rupture of the urethra, however, is accompanied by retention of urine, and by the presence of a tumor in the hypogastrium, formed by the distended bladder. In rupture of the bladder, nothing of this sort is observed.

Prognosis.—The immediate prognosis varies essentially with the nature of the lesion, and from this stand-point the various cases may be arranged in three categories: cases of slight gravity, cases of moderate gravity, and cases of decided gravity. *Cases of slight gravity* correspond to ruptures of the first degree, and to those of the second in which the lesion consists of a simple fraying of the mucous membrane, with complete integrity of the fibrous coat and of the subjacent tissues. From the clinical point of view they are characterized by the absence or smallness of the hemorrhage from the urethra, the ready though painful micturition, the immediate success of catheterization, and the absence of a tumor in the perineum, or the presence of a simple collar at the level of the point of contusion. In such cases it is usual to observe a gradual disappearance of all the symptoms, and a rapid progress to recovery. Quite often, however, a primary or secondary communication is established between the urethra and the subjacent point of injury, and the formation of an abscess follows. But this complication, which is at any rate not very serious, has no effect except to delay recovery.

In cases of moderate gravity the mucous membrane is ruptured transversely, but only for a part of the circumference of the canal, and ordinarily at its lower wall. The spongy tissue is torn at the same level, and furnishes the greater part of the blood which flows from the meatus. The fibrous tunic usually gives way, allowing blood to be effused into the tissues of the perineum; but it may remain intact, when the focus of injury communicates with the urethra alone. In such cases the hemorrhage from the urethra is much more abundant, and continues almost without interruption. There is no retention of urine, properly so called, but micturition is difficult and painful. Moreover, catheterization is usually possible if care be taken to follow the upper wall of the canal with the beak of the catheter, and, finally, the perineum is the seat of a more or less voluminous tumor. In such cases, in spite of the extent of the lesion, complete recovery may follow under proper treatment; but in the great majority of instances complications arise, ranging from a simple abscess to a more or less extensive phlegmon with the formation of a variable number of fistulæ.

In cases of decided gravity the rupture is always complete, often total, and accompanied by considerable retraction of the divided ends. Retention of urine is absolute, catheterization impossible or exceedingly difficult, the hemorrhage from the urethra copious, and the perineal tumor voluminous. The abundant effusion of blood and the laceration of the neighboring tissues bring about, almost inevitably, one of the most formidable complications, infiltration of urine extending through the whole perineum. Finally, it must not be forgotten that all ruptures of the urethra, however slight they may be, lead as a remote consequence to the formation of a stricture. This result is constant, and rarely requires more than two months to manifest its existence.

Treatment.—The numerous and deep discussions of which the management of ruptures of the urethra have formed the subject, make it possible at the present day to lay down rules for their treatment with sufficient precision. In what follows I shall have in view chiefly ruptures of the perineal portion. Here the division which I have made into cases of slight gravity, cases of moderate gravity, and cases of decided gravity, is of great importance. In *cases of slight gravity*, the part of the surgeon ought to be one of temporizing and watching: to meet the immediate exigencies, to combat hemorrhage by compression and cold, to overcome retention of urine by catheterization with a flexible catheter, to await events, and to watch what is going on in the perineum so as to be ready to act at the first sign of inflammation or infiltration.

In *cases of moderate gravity*, an attempt should be made to prevent the passage of urine into the focus of the rupture by means of the introduction and retention of a catheter, of a size large enough to fill the canal. At the same time the state of the perineum must be watched with attention, so as to act at the slightest threat of infiltration or of phlegmon. If catheterization be impossible, we should proceed as in *cases of decided gravity*, which are next to be considered. Here the retention of urine on the one hand, and, on the other hand, the difficulty, danger, and often impossibility of catheterization, furnish the indication for treatment. To meet it the surgeon has two methods at his disposition: puncture of the bladder, and perineal section, or, rather, immediate external urethrotomy. *Supra-pubic puncture*, the only form to which recourse should be had, carried out with either the ordinary trocar or the capillary aspirator, may be temporarily employed, especially if the surgeon is not prepared for more serious operative intervention. But this is only a palliative measure, giving only temporary relief, and by no means preventing suppuration of the perineal tumor and the establishment of fistulæ. On the contrary, immediate *external urethrotomy*, at the same time that it meets the immediate exigencies, protects the patient against subsequent complications. To this the preference should be given.

The following is a brief description of this operation: The patient being laid upon his back, in the lithotomy position, the perineum is incised, layer by layer, in the middle line and at an equal distance from the two ischia. In this way the effusion of blood is first reached, the clots being turned out with the finger, and then the ruptured urethra. When this is done, and in order to introduce the catheter which is to be retained, the two ends of the divided urethra must be sought for. The anterior one presents little difficulty. A sound introduced by the meatus readily discloses it. It is quite otherwise with the posterior end, the search for which constitutes the most delicate part of the operation. Sometimes it is possible, if the rupture is not total, to enter the bladder by following with a guide the little tongue which still persists at the upper wall of the canal. Or the patient is instructed to make efforts which may lead to the escape of a certain quantity of urine; or, yet again, it may be possible, by pressing gently but with some force on the hypogastrium, to effect the passage of some drops of urine. If none of these plans succeed, it is possible, as Demarquay has advised, to discover the urethra at some distance from the lesion by means of an incision like that of bilateral lithotomy, to divide the canal at this point, and through this opening practise retrograde catheterization. If even this attempt should fail, and if retention should persist, the bladder should be punctured above the pubis with a trocar, so as to permit, immediately or at a later time, a search for the vesical orifice, and the introduction through this orifice of a catheter which shall come out at the proximal end of the divided urethra. [Another plan is to open the urethra at the apex of the prostate, and therefore behind the usual seat of rupture, by what is known as Cock's method,[1] introducing a broad director into the bladder, and using this as a guide for the passage of the catheter.]

Afterwards the patient may present himself with the ordinary consequences of a rupture of the urethra—stricture or fistulæ. The treatment of these sequelæ will be indicated hereafter.

TRAUMATIC LESIONS OF THE URETHRA PRODUCED FROM WITHIN OUTWARDS (FALSE PASSAGES).—When a foreign body is introduced roughly into the urethra, or when a fragment of calculus is arrested in this passage, more or less extensive lacerations are observed, followed or not by accidents. These lesions will be studied hereafter. At present we have in view only perforations or contused wounds of the urethra, caused by instruments in catheterization. It is to these lesions that the name "false passages" is given.

Pathological Anatomy.—The location of false passages is very variable. They have been found in all parts of the urethra, from the fossa navicularis to the neck of the bladder; but they are oftenest met in the deeper parts of the canal. Sometimes they are shallow, sometimes they penetrate more than ten centimetres into the depth of the tissues; most frequently they are incomplete, and end in a *cul-de-sac;* sometimes, on the contrary, after having burrowed out from the urethra, they find their way back into the bladder, and are then called "complete." It is rarely that false passages are found in a normal urethra, in which there is no obstruction to catheterization. Some, however, have been observed under these conditions, and this is the way in which they may occur: Either when the catheter has reached the *cul-de-sac* of the bulb, it is pressed straight on without the handle being lowered, when it pierces the lower wall of the canal and passes under the membranous portion between the prostate and the rectum; or the operator lowers the handle of the catheter too soon, and then the beak of the instrument perforates the upper wall of the urethra and passes behind the symphysis pubis. In the first case the catheter may still reach the bladder by perforating it at the *bas-fond*, or at one of its sides; in the second, on the contrary, the more the sound is lowered the more its beak tends to leave the anterior face of the bladder.

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[1] See p. 413, *supra.*

Much more frequently the production of a false passage depends upon a pathological condition of the urethral walls. It is not rare to find lacunæ of Morgagni so large that a delicate and stiff bougie, especially if made of whalebone, may be caught in one of them, perforate the mucous membrane, and then after a short passage through the submucous tissue perforate it again so as to re-enter the canal. In other cases there are, in the prostatic portion of the urethra, cavities in which the instrument may be caught. Sometimes the mucous membrane presents, on each side of the verumontanum, a shallow *cul-de-sac*, a sort of sinus, opening in front: sometimes the orifices of the glands of Cowper are ulcerated and enlarged. In some old men, the urethral mucous membrane is so lax that it is rolled up by the catheter in front of the neck of the bulb, where it forms a fold which makes a hood, so to speak, on the beak of the instrument. But the two commonest causes of false passage are the presence of hypertrophy of the lateral lobes, or of the middle lobe, of the prostate, and above all the existence of a stricture; and this accident is found to happen all the more readily the more the stricture is narrow, tight, and deeply situated. In such a case the instrument is arrested, and if the surgeon uses force, its beak turns aside and perforates the healthy wall of the canal, which offers less resistance than the stricture itself.

The consequences of such a lesion vary with different cases. If the false passage be incomplete, and the instrument slender, inflammation is moderate and recovery quickly secured. A complete false passage, on the contrary, must be considered a grave lesion. The penetration of urine into this newly formed canal always produces either a urinary abscess or an infiltration of urine, and often fatal inflammatory accidents. An exception should be made of false passages which tunnel the thickness of the prostate, and which, if not always devoid of danger, sometimes constitute a fortunate accident for the patient. Indeed the formation of such a false passage has been formulated as a method of treatment.

Diagnosis.—It is easy to recognize that a false passage is being made. After having discovered the presence of an obstruction, suddenly there is felt a sensation of resistance overcome, then of tearing, of which the patient himself is often conscious. The catheter, instead of progressing continuously toward the bladder, advances only by jerks. If it be withdrawn a little, it is not felt to be gripped as it would be in a stricture. The finger, introduced into the rectum, feels that the instrument is separated from it by only a very thin layer of tissue, and that it deviates more or less to one side. Finally, the catheter may have been buried very deep without giving exit to the urine, and its withdrawal is accompanied by a slight hemorrhage. It is often more difficult to recognize an old false passage in a patient treated before by another surgeon. The catheter then goes directly into the false passage, and is arrested. The nature of the obstacle is unknown, and it may be thought that there is present a stricture in which the instrument is engaged, and which it cannot pass. But if the patient can urinate so well that the hypothesis of an impassable stricture is inadmissible; if, at a certain time in the catheterization, the instrument inclines spontaneously to the right or left; if, with the finger introduced into the rectum, it is ascertained that the beak of the instrument has deviated from the middle line, the presence of a false passage may be considered as demonstrated.

Treatment.—An incomplete false passage, made with a delicate instrument, constitutes an accident which is usually of no consequence, and which requires no special treatment. If, on the contrary, the false passage has resulted from the introduction into the urethra of a large instrument, and if it is complete, it becomes necessary to look after the patient with great care. It is necessary then to have recourse immediately to an energetic antiphlogistic treatment (blood-letting, baths, local emollient applications), and to be ready to meet such serious developments as suppuration and infiltration of urine. The best way to prevent these complications consists in the introduction and retention of a catheter which will enable the urine to flow freely, and which will have the additional advantage of distending the canal fully and pressing the walls of the false passage together, so as to favor their cicatrization. But further, it is necessary that the canal shall be free. When, in consequence of the existence of a stricture, catheterization is impossible, two cases may present themselves: either the patient can pass urine, when the treatment is limited to the employment of antiphlogistics while awaiting the healing of the false passage; or, on the contrary, there is retention of urine, when it is necessary to have recourse to external urethrotomy or to puncture of the bladder.

Foreign Bodies in the Urethra.

Foreign bodies in the urethra may be arranged in three classes according as they come from the bladder, as they have been formed *in situ*, or as they have come from without and have been introduced by the meatus.

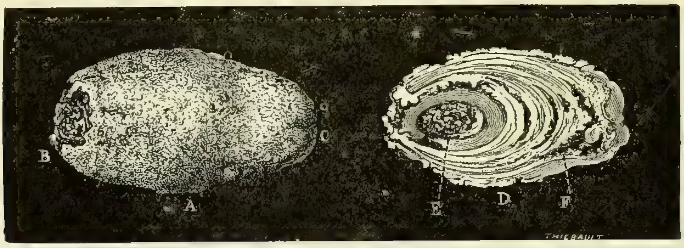
Foreign Bodies coming from the Bladder.—Foreign bodies which come from the bladder are sometimes concretions which have descended from the kidneys, sometimes the *débris* of vesical calculi left by an operation of lithotrity.

Pathological Anatomy and Physiology.—Calculi which have descended from the kidneys are small, quite regular, rounded or flattened like a bean, or sometimes elongated and fusiform like the stone of an olive. Sometimes they are grayish, with a rough surface; sometimes, and more frequently, they have a rich red color and a perfectly smooth surface. Fragments of vesical calculi are often very large. They are always irregular, and have ridges and points more or less acute. Their color and consistence vary with those of the calculi from which they are derived. Foreign bodies coming from the bladder may stop at any point in the urethra, but they are usually found at the level of the narrowest portions of this tube (neck of the bulb; fossa navicularis). If the calculus be small, it is not unusual for it to be expelled with the urine after some moments or some hours, without having produced any serious disturbance. In other cases, and under the influence of various causes—such as the size of the foreign body, the irregularities which it presents and which fix it in the urethral mucous membrane, spasm of the canal, the existence of a normal or pathological narrowing, or considerable dilatation of the lacunæ of Morgagni—a calculus may be retained in the urethra for months and even for years.

It may be easily conceived that so prolonged a stay is accompanied by notable modifications on the part of the canal and on the part of the calculus. In children, in whom the urethra is supple and dilatable, there forms up-stream from the obstacle a veritable pocket, the size of which may equal or exceed that of the fist. Then the calculus is often quite easily displaced, falls into the pocket, and then resumes its former position; from whence arise the alternations of dysuria and easy micturition which are observed in such cases. In adults, the walls of the canal likewise are capable of distension above the obstacle, but rarely to the extent of forming a true pocket. On the part of the calculus, a series of modifications are observed which recall quite exactly what happens to vesical calculi. In consequence of the precipitation of the salts of the urine, and of the formation round the original calculus of more and more numerous concentric layers, the latter increases in size and may attain the dimensions of an egg.[1] This great increase in the size of the foreign body, however, rarely causes complete retention. Most frequently there exists only marked, very marked, straining in micturition; the increase in volume, taking place very slowly, gives the urethra time to dilate; moreover, there always forms, either on the lower surface or on both surfaces at once, a sort of canal or groove which permits a flow of urine.

The increase of calculi arrested in the urethra does not take place as regularly as that of vesical calculi. In the penile portion, where the dilatability of the walls is least marked, the increase occurs chiefly in length and mostly at the posterior part, as is shown by the position of the primitive nucleus, which is always found at the anterior extremity of the calculus, when this is divided in its principal axis. (Fig. 1318.) The nucleus, small, hard, ovoid, is formed of uric acid; the rest of the calculus is made up of calcareous salts. In some cases the urethra, dilated for a space of from eight to twelve centimetres, contains several calculi placed end to end, the whole of which represent a long ovoid, ending in points at the two extremities. (Fig. 1319.) Are these a number of calculi coming from the bladder, or fragments of one and the same calculus? The latter view appears to be the true one, when account is taken of the existence of a single nucleus at the anterior extremity, and of the exact fitting of the facets of each of the fragments with those of the fragment following it.

Fig. 1318.



Calculus lodged in the fossa navicularis for thirteen months. (After Voillemier.)

It may happen, however, and chiefly after an operation of lithotrity, that a number of fragments, coming from the bladder, are arrested in the urethra; but then they are small, more or less numerous, without any nucleus, and lodged promiscuously in a dilatation of the canal. Tulpius reports a good example of this observed in a child, whose urethra he incised in its middle portion and removed from it twenty-five calculi.

In the membranous and prostatic portions, which are much more dilatable than the penile portion, the development of calculi takes place with more facility. When the calculus is single, it forms a mass, most frequently the size of a nut, irregularly rounded, a little longer than it is broad, concave on its lower surface, slightly convex on its upper surface and often traversed by a groove running from behind forwards, presenting on section a nucleus which is often hard to recognize, and which is placed nearer the upper than the lower surface. Here, as in the penile portion, the deposits accumulate chiefly at the posterior part of the calculus. This mode of increase may give rise to the formation of a special variety of calculus called urethro-vesical (Fig. 1320), composed of two masses, the one urethral, the other vesical, and united by a prolongation as thick as a large quill and six or eight millimetres in length. The intra-vesical portion is flattened, ovoid, with its long diameter antero-posterior, extending rather below than above the level of the neck of the bladder. Quite often a spontaneous rupture of the prolongation which unites the two portions of the calculus occurs, a rupture which is easily explained by the thinness of the part, and by the shocks communicated to it by contractions of the neck of the bladder and efforts of defecation. Sometimes, even, rupture takes place before the prolongation reaches the bladder. Then the two fragments present the exact adjustment and the smooth state of the surfaces which are observed in the penile portion.

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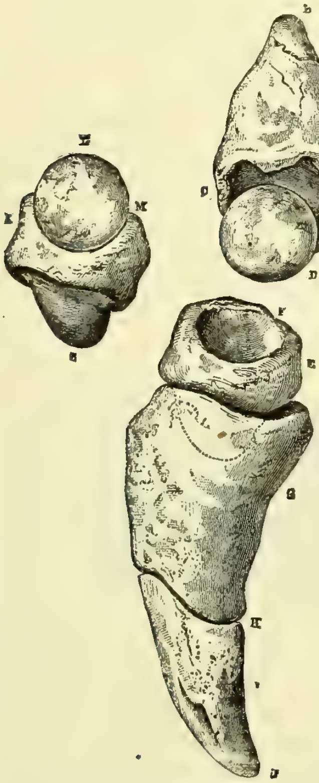
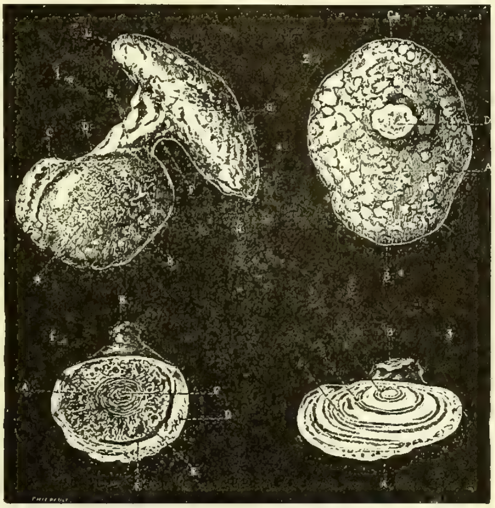
[1] J. L. Petit, Œuvres Posthumes, tome iii. p. 13.

Fig. 1319.



Urethral calculus composed of ten pieces. (After Voillemier).

Fig. 1320.



Urethro-vesical calculus, entire and cut. (After Voillemier.)

Symptomatology and Diagnosis.—The first phenomenon observed at the moment when a calculus enters and is arrested in the urethra, is an abrupt interruption of the stream of urine. In children this accident occurs altogether without warning. In adults, on the contrary, it is habitually preceded by pain in the region of the kidneys and by the expulsion of gravel. Often, also, the calculus does not cause complete retention, but a simple difficulty in passing water. The pain is of very variable intensity according to the cases. Almost wanting in the case of a smooth and rounded renal calculus, it may be very acute, and accompanied by hemorrhage from the urethra, if the foreign body is a rough calculus or a calculous fragment. The preceding symptoms point almost surely to the lodgment of a foreign body in the urethra; but it is always necessary to complete the diagnosis by sounding with a metallic instrument. If the calculus be large, it will check the passage of the sound, and it will be possible, either by tapping it lightly or by rubbing against the obstacle with the beak of the sound, to gain a sufficiently exact notion of its consistence and of the state of its surface. If the calculus be very small, the sound may pass alongside of it, but in thus doing it will communicate to the operator a peculiar sensation of rubbing or grating.

So far I have supposed that the surgeon has been summoned immediately; but is the diagnosis more difficult in the case of a stone which has been for a long time fixed in the urethra? The information furnished by the patient is then incomplete or inexact, the sound itself may pass alongside of the foreign body, lodged in a pocket or dilatation of the canal, without eliciting any physical sign. It is necessary then, if there be a calculus of the penile portion, to palpate the penis thoroughly, and then to explore the canal with a curved sound, the point of which is directed toward the tumor which has been felt from the outside, and which is fixed with the fingers.

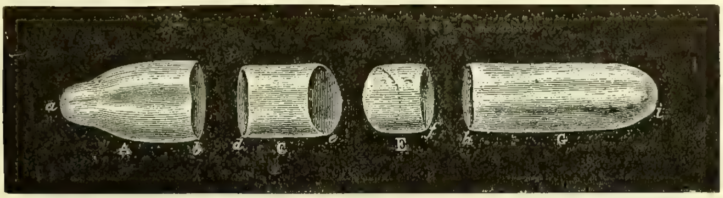
Is there a calculus arrested in the membranous or prostatic portion? By palpating the perineum carefully, by practising the rectal touch, there is found a hard, immobile point, not well circumscribed, which might, it is true, be confounded with a tumor of the prostate, or with a urinary abscess in process of formation. But by inquiring carefully for its antecedents, the surgeon will almost always discover some circumstances calculated to clear up the diagnosis. Thus, he will discover either that the patient has voided gravel, or that he has been seized at a given time with a sudden difficulty in urinating. At other times, sounding is easily carried out upon a patient in whom the presence of a urethral calculus is suspected, but the sound rubs against a hard and rough body in the deep portion of the canal. Under such circumstances one might hesitate between a calculus of the prostatic portion and a stone lying in the bladder close to the neck. In such a case one should explore the membranous and prostatic portions by the rectum, and find out that there is no tumor there. Then the prostate should be lifted up toward the pubis at the same time that the sound is gently introduced into the urethra. In this way the moment when it encounters the calculus can be learned. Further, a catheter with the opening at its tip might be used for this examination, and if, at the moment when it touches the stone urine does not flow, the calculus is urethral. Finally, on exploring the bladder with a lithotrite, if it be not possible to seize the calculus with this instrument, one may be sure that it is not in the bladder.

It may happen that there is at the same time a calculus in the bladder, and another in the urethra. Then the first may be seized with the lithotrite, and the instrument be moved to and fro, when it will be easily felt to rub against a hard body situated in the canal.

Prognosis.—When a calculus is small, it not infrequently happens that, after remaining a short time in the urethra, it is driven out by the stream of urine without having given rise to any disturbance. More voluminous stones, unless they undergo the modification which I have indicated in consequence of their long sojourn in the canal, inflame the tissues with which they are in contact, ulcerate through them, and end by escaping externally. If a calculus is so small as to interfere only moderately with the flow of urine, it may slowly ulcerate the walls of the urethra and burrow out a cavity in the neighboring tissues, large enough to wholly contain it. Calculi have been known to remain thus for a very long time, as if encysted, without the occurrence of anything to betray their presence; then, under the influence of a new accession of inflammation, to make their way toward the skin, and sometimes to end by being expelled without having occasioned any serious disturbance. Most frequently, however, the urine, escaping with difficulty by the meatus, infiltrates widely through the perforation of the urethra made by the calculus, and thus sets up the gravest disorders.

Foreign Bodies formed in Situ.—I will simply mention here concretions developed in the body of the prostate, the study of which belongs to that of this gland itself; they have been considered in another portion of this volume.[1] I shall place in this second class only calculi found behind a stricture, in a urinary pocket, in the focus of an old urinary abscess, or in a simple sinus due to stagnation of urine and precipitation of the salts which it holds in solution. In this category may be included also stones which develop in an abnormal cavity communicating with the urethra, to which Louis first called attention. The chemical composition of these calculi may serve to distinguish them from those which come from the bladder. Whilst the latter have a uric-acid or oxalic-acid nucleus surrounded by a variable number of perfectly distinct phosphatic layers, calculi formed in the urethra are made up entirely of phosphate of lime (Fig. 1321), in scarcely appreciable concentric layers, or with these entirely wanting and with a uniform agglomeration of their constituents.

Fig. 1321.



Urethral calculus of phosphate of lime, natural size.

The *symptomatology* of these calculi is perfectly analogous to that of calculi which come from the bladder; with this difference, however, that those of the second class, because of their situation in a cavity which lies near to the integument, interfere less with the flow of urine, and have a greater tendency to make their way out rapidly through the skin.

Treatment.—There are three methods of treatment for calculi lodged in the urethra, applicable to the two varieties which we have just studied, but having each its special indications: *extraction through the meatus*, *propulsion into the bladder*, and *extraction by an artificial opening.*

(1) *Extraction by the meatus* is easy when the calculus is situated near the extremity of the penis. The calculus is seized with forceps, after slightly enlarging the meatus, if necessary. When the calculus is more deeply placed, it is necessary to employ other manœuvres, and especially other instruments. At first an attempt may be made to displace the calculus with a stylet, then, after having pinched the meatus between the fingers, the patient is to be made to urinate and induced to strain with all his might. Not infrequently then the calculus, if it be not very voluminous, will escape of itself. It is possible, again, to secure this result by passing a large, flexible catheter down to the seat of the foreign body, leaving it in position for several hours, and removing it when the patient wants to urinate. If these simple measures do not succeed, it becomes necessary to make use of special instruments, either an ordinary curette, or, better, the articulated curette of Leroy d'Étiolles. This instrument (Fig. 1322) is composed of a flattened metallic canula, carrying

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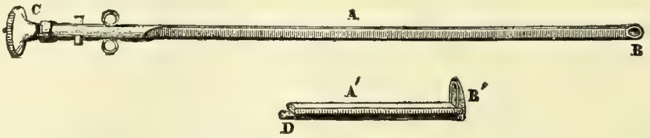
[1] See p. 392, *supra.*

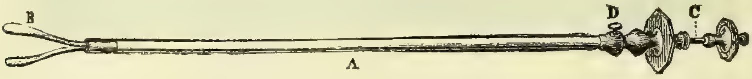
at one of its extremities a small articulated curette, which may be inclined at will at a right angle by means of a brass wire concealed in the hollow of the canula. The instrument is introduced into the urethra with the curette in the same axis as the instrument, and the curette is raised as soon as it has passed the obstacle. The calculus being thus hooked up, it is gently drawn out. This ingenious and useful instrument is not the only one which has been devised. Marini used a solid rod, terminated at one of its extremities with a metallic wire forming an elongated loop which was moved about in such a manner as to lay hold of the calculus. The somewhat primitive apparatus of Marini has been improved by J. Cloquet, and transformed by him into a sort of *serre-nœud.* But of all the instruments, the best is that which is known by the name of "Hunter's forceps." (Fig. 1323.) It is composed of a metallic canula, open at both ends, and containing in its cavity a shaft terminating in two or three branches, three centimetres long, convex without and concave within. These branches, which separate when they are free, come together when the shaft is drawn back, and re-enter the canula. The forceps are thus introduced into the urethra, and the canula is drawn back as soon as the obstacle is reached, when the branches, being set free, separate and embrace the calculus, and, when the stone is once grasped, it is only necessary to push the canula forward again and to draw the instrument out.

Fig. 1322.



Jointed curette of Leroy d'Étiolles.

Fig. 1323.

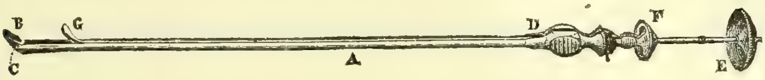


Hunter's forceps.

If a calculus be situated in the deepest part of the urethra, a straight instrument cannot be used. Then recourse can be had either to the curved forceps of Voillemier—a kind of sound, the two halves of which form a spring and separate as soon as they cease to be pressed together—or to the forceps of Cusco, the two branches of which separate only at their extremities by means of a special mechanism.

But there are some cases in which, either on account of the size of the stone or in consequence of its imprisonment in the urethra, the above described instruments are inadequate. It is for such cases that urethral lithotrity has been proposed. This operation is of very ancient date. Already described with some details by Albucasis, it was set forth with much more precision by Franco, whose method consisted in fixing the calculus with a ligature placed round the penis, perforating it with a gimlet, and then squeezing it between the fingers to effect its rupture. The surgeons of the last century attached only moderate importance to the crushing of stones in the urethra; the invention of lithotrity recalled attention to this operation. Then were invented the urethral lithotrites of Dubowisky, of Leroy d'Étiolles, of Nélaton (Fig. 1324), and of Reliquet. All these instruments are open to the same objection: their manipulation is difficult, and it exposes the urethra to the gravest lesions. It is for this reason that, although practicable with advantage under certain circumstances, urethral lithotrity must be considered as inferior in value to other methods, such as propulsion toward the bladder, or incision of the urethra.

Fig. 1324.



Nélaton's urethral lithotrite.

(2) *Propulsion of the calculus into the bladder* is suited, naturally, only to stones arrested in the deep portions of the urethra. It is easily accomplished with the help of a large metallic sound, with which the foreign body is gently pushed back until it falls into the bladder. When this result is obtained, the surgeon proceeds, either at once or some days afterwards, to crush the stone with a lithotrite.

(3) *Incision of the urethra* may be practised upon any part of the canal, but it is especially adapted to cases in which the calculus is arrested in the spongy portion. In such cases the operation is very simple. The foreign body, which forms a more or less voluminous tumor, is firmly held between the fingers, while the surgeon incises the soft parts directly upon it, and makes an opening just sufficient to give exit to the calculus. When this is extracted, the little wound may be closed immediately with a few points of suture, or its healing may be left to Nature, but with the precaution in both cases of introducing a catheter and leaving it in the urethra. The arrest of a calculus in the urethra is sometimes complicated by the presence of a stricture, situated in front of the calculus. What should be the conduct of the surgeon in such a case? If the stone be small, and if the patient can pass water, it will be advisable to practise dilatation of the stricture, and, as soon as the canal is sufficiently enlarged, to extract the foreign body with a special instrument. If, on the contrary, the patient be unable to urinate, and the extraction of the foreign body must be effected immediately, two cases may present themselves. Sometimes the stone is small enough to pass through the canal, if free from obstruction; then recourse should be had to internal urethrotomy. Sometimes the calculus is large, and its extraction impossible even after division of the stricture; then the urethra may be incised upon the foreign body without hesitation, and the opening thus made may be utilized to divide the stricture at the same time, and to effect its cure.

FOREIGN BODIES INTRODUCED THROUGH THE MEATUS.—Foreign bodies arrested in the urethra after having entered it by the meatus, are so numerous, and differ so much one from another in dimensions, form, and nature, that it would be almost impossible to give a complete list of them here. Ordinarily they are, in adults, needles, pins, pencils, pieces of wood or hay, pipe-stems, heads of grain—introduced most frequently for unnatural purposes, sometimes to alleviate pain or simple itching; in children, stones of fruits, grains, pebbles, balls of glass or metal, and other playthings. In other cases they are ends of gum or metal catheters, or fragments of lithotrites or caustic-holders broken during an operation. All these objects, once engaged in the urethra, have a marked tendency to pass more deeply within it, as if the bladder exercised upon them a sort of attraction or aspiration. This phenomenon is explained easily enough in the case of elongated foreign bodies, blunt at one end and pointed at the other, by the pulling practised on the penis by the patient. The walls of the canal slide easily over the foreign body, the point of which is directed toward the meatus; but they drag it back in their retreat by a mechanism absolutely analogous to that which children employ to make heads of grain climb up the sleeves of their clothes. Sometimes another factor is concerned: this is an erection, preceding or immediately following the introduction of the foreign body; as soon as it passes off, the foreign body is found to have been carried more deeply. This tendency of foreign bodies to penetrate further and further is so strong that sometimes it drives them even into the bladder.

Symptomatology.—The presence of a foreign body in the urethra causes at once greater or less difficulty in micturition; pain, the degree of which is determined by the nature of the obstacle; and a more or less abundant flow of blood. Inflammatory manifestations soon follow, aggravated by the attempts at extraction made by the patient himself. A discharge from the meatus is set up, at first sero-sanguinolent, and soon purulent; the swollen penis becomes bright red in color, and a high fever is developed. This may give rise to fear of a more or less extensive phlegmon, or even of gangrene of the whole penis; but often a simple urethral abscess is seen to follow, the foreign body escaping either by the meatus or through a perforation of the skin of the penis, or even passing on into the bladder. Sometimes, in spite of a prolonged stay of the foreign body in the urethra, the inflammation declines spontaneously without the occurrence of any of the preceding terminations; but then the object, fixed in the canal, is encrusted with calcareous matters, and becomes the occasion of a urethral calculus. These secondary accidents are however very rarely observed, for the frightened patients make haste to secure the aid of a surgeon.

Treatment.—It is easy to understand that, on account of the infinite variety and diverse location of foreign bodies introduced through the meatus, it must be impossible to lay down general rules for their extraction. If the object has only partly entered the urethra, and if it is still protruding externally, it will very often be easy to extract it with forceps, or even with the fingers. Certain bodies, however, because of their shape, present special difficulties. Thus it would not be possible to pull upon a head of grain without tearing the walls of the canal. In such a case the head should be tied, at the level of the meatus, with a thread, the two extremities of which are passed through a silver canula, open at both ends; then, at the same time that the thread is drawn upon with the left hand, the canula is pushed down with the right, so as to disengage the barbs of the head of grain by a manœuvre identical with that devised by Marchettis to extract a hog's tail which had been introduced into a prostitute's rectum.

If the foreign body be completely hidden, and have passed deep into the urethra, the difficulties are much greater; often, however, when the object is small and rounded, like a cherry-stone, or a glass or metal ball—or even when it is an elongated body, but with a smooth cylindrical surface and a rounded anterior extremity—extraction may be easily accomplished by means of pressure from behind forwards. In case of failure, the forceps of Hunter should be used, or the articulated curette of Leroy d'Étiolles. But these manœuvres will not succeed in dealing with an object the ends of which are pointed like a needle or a pin. In such a case the following procedure, long since devised by Deschamps, should be employed. This consists in bending the penis, piercing the urethra and the skin with the point of the needle, and extracting it by this aperture. If the needle has penetrated to the perineal portion, the left index may be introduced into the rectum and made to push it through the integuments, and it may be withdrawn as in the preceding case. If the foreign body be a pin, one may begin, as above, by pushing it through the walls of the canal; then it may be cut off even with the skin, and the head extracted through the natural passage with the forceps of Hunter or of Cusco. The following method, proposed by Caudmont, may also be attempted: instead of forcing the pin through the walls, an attempt is made to disengage it; then a large wax bougie is introduced into the urethra, into which the point of the pin is to be thrust, and then the whole is to be drawn out together.

There have been devised a number of instruments for the urethra, analogous to those employed to extract metallic bodies of small dimensions from the bladder. But these instruments are only very rarely used.

To extract ends of catheters, which are generally lodged in the membranous portion of the urethra, the forceps of Hunter may be used with great advantage. Further, it very often suffices to shake the fragment of a catheter a little, in order to secure its discharge by the stream of urine. I will mention, also, the ingenious method devised by Voillemier in a case in which one of the sections of a pocket-catheter was left in the canal. Having introduced a finger into the rectum to furnish a point of support to the catheter, he insinuated into the cavity of the latter a small catgut bougie, which he allowed to remain for two hours, until it had time to swell up; and with it he withdrew the end of the catheter.

If, finally, the size, the shape, and the situation of the foreign body make extraction by the preceding manœuvres impossible, a small opening may be made at the level of its anterior extremity, and through this opening it may be extracted with forceps.

Vital and Organic Lesions of the Urethra.

Inflammation of the urethra, or urethritis, will not be referred to here, as it has already been fully considered in the article on Gonorrhœa in the second volume of this Encyclopædia.

Stricture of the Urethra.—There are a great many causes capable of diminishing the calibre of the urethra; tumors of the penis and of the perineum, foreign bodies, and calculi, may by their presence occasion a more or less complete obliteration of the lumen of the canal, to which, however, the name of stricture could only be applied by a veritable abuse of language. True strictures, the only ones which deserve this name, are those in which the cause of the coarctation resides in the very walls of the contracted channel; and here again several divisions should be admitted.

Urethritis is accompanied in certain cases by a more or less marked tumefaction of the urethral mucous membrane and of the subjacent tissues, which effaces to a greater or less extent the lumen of the canal, and thus produces an *acute inflammatory* stricture, which disappears with the disorder which gave it birth. Further, stricture results from modifications, brought about by the fact of inflammation, in the structure of the normal walls of the urethra—modifications which survive the primary inflammation, lessen the elasticity of the tissues, and give them a persistent tendency to contraction. Hence the formation of an *organic* or *chronic inflammatory stricture*, as it has sometimes been called. In another form, the walls of the urethra have been ruptured by a traumatism, or destroyed by ulceration. In both cases the interposition between the lips of the wound of a tissue of new formation is the origin of a stricture called *cicatricial*. These last two varieties alone will occupy us in this study. *Spasmodic stricture*, or rather *spasm of the urethra*, will be discussed hereafter.

In all time, strictures of the urethra have attracted the attention of surgeons, and medical literature is extremely rich in regard to this subject.

Etiology and Pathogenesis.—Two orders of causes concur in the production of strictures: sometimes they are due to inflammation, which modifies the tissues constituting the tunics of the urethra, deprives them of their suppleness, and impresses upon them a mode of vitality of which the principal characteristic is contractibility; sometimes they succeed a traumatism which determines a solution of continuity, a loss of substance in the urethral walls, the repair of which brings about the formation of a cicatrix, essentially contractile. To these two varieties of stricture (inflammatory and cicatricial) may be added a third, which has a similar pathogenesis; I mean that variety which supervenes upon an acute inflammation, followed by ulceration and loss of substance, the repair of which induces the formation of inodular, contractile tissue. In these cases, which are, however, exceptional, the stricture is at the same time both inflammatory and cicatricial.

(1) *Inflammatory Strictures.*—The works of J. Guérin, of Mercier, of Cruveilhier, and of A. Guérin,[1] have especially contributed to elucidate the pathogenesis of this class of strictures. Everybody is agreed nowadays to consider inflammatory strictures as the result of infiltration of the submucous tissues, of obliteration of the vascular spaces, and of fibrous organization of exudates, ending finally in contraction and atrophic condensation of the normal tissues. As to the mucous membrane itself, always more or less intact, since its lymphatic vessels remain permeable, it is simply pushed back toward the axis of the canal. This plastic infiltration of the connective, muscular, and spongy tissues, which follows inflammation of the mucous membrane of the urethra, is not, however, necessarily followed by formation of a stricture. The exudate may be soon absorbed, and this complication may be absolutely wanting after even very intense urethritis. On the other hand, quite often, in consequence of peculiar idiosyncrasies, the exudate is seen to become organized, and stricture to follow inevitably, in individuals affected with urethritis which is benign and of only short duration. Most commonly, complete resorption is prevented by some cause which maintains and prolongs acute phlegmasia, and gives it chronicity. Such constitutional and diathetic conditions as arthritis, herpetism, and scrofula, appear to possess positive influence in this regard, and as much may be said of errors of regimen, and of direct irritation resulting from indiscreet manœuvres with the catheter, or from caustic injections, which bring about successive returns to an acute state, and thus prevent resolution of the neoplasm.

(2) *Cicatricial Strictures.*—Less common than the preceding, these strictures are the consequence of a lesion of the walls of the urethra, causing a more or less extensive loss of substance which cannot be filled up without the interposition, between the lips of the wound, of an essentially contractile cicatrix. Contrary to what we have seen in inflammatory strictures, the mucous membrane is here completely destroyed and replaced by inodular tissue, which does not admit of being penetrated by injection of the lymphatics. The production of cicatricial tissue is not, however, the only cause of coarctation here, and inflammation of the submucous tissues likewise plays its part. Most cicatricial strictures result from a traumatic lesion of the urethra: a simple wound with a cutting instrument, a contused wound caused by falling astride upon the perineum, a surgical operation, such as catheterization or lithotrity, or, again, the lodgment of a foreign body. But

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[1] Mém. de la Soc. de Chir., t. iv. p. 122.

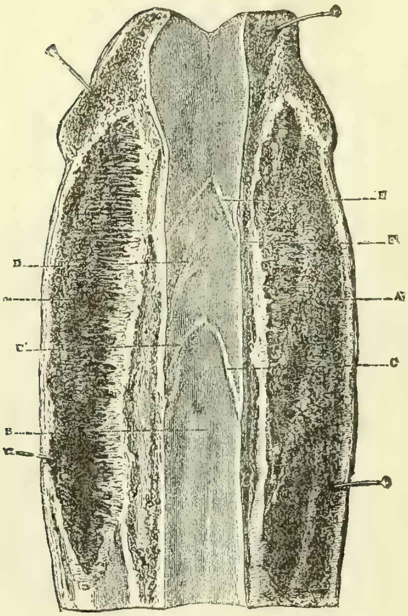
a cicatricial stricture may also be produced in consequence of ulceration of any kind which has destroyed the mucous membrane, and has attacked the submucous tissues. The chancroid very frequently causes this form of stricture. Ulceration in acute urethritis is, on the contrary, extremely rare, almost always superficial, and the resulting stricture, if any, not very pronounced.

Pathological Anatomy.—The pathological anatomy of stricture of the urethra was completely unknown to the ancients, and all the manifestations which characterize retention of urine were charged to *caruncles* or *carnosities*, situated in the neck of the bladder or along the canal of the urethra. These ideas were replaced, after the first years of the eighteenth century, by the theory of *cicatricial* contraction, following ulceration of an inflammatory nature which had destroyed the mucous membrane and a part of the subjacent tissues—a theory contradicted by facts, and for which modern authors have substituted, in the last forty years, more exact notions about the nature of the lesions which give rise to strictures. I will consider separately each of the forms of stricture which I have admitted, and will take up first the inflammatory or organic stricture.

(1) *Inflammatory Strictures.*—In its mildest degree, and in cases in which the inflammation has attacked only the mucous membrane and a very slight thickness of the subjacent tissues, the stricture consists in a scarcely appreciable diminution in the calibre of the urethra, which is the result of a very slight induration of the submucous tissue, causing a trifling elevation of the mucous membrane. The little ridge thus formed usually occupies the anterior third of the penis, and only rarely extends over the whole of the circumference of the canal. It may be single, but ordinarily there are two or three such ridges (Fig. 1325), which are separated by a space of one or two centimetres, and in the interval between which the urethra appears absolutely healthy. The mucous membrane which covers them is sometimes free and mobile; sometimes adherent, pale, a little depressed, and slightly puckered. But even this is not a true stricture. To produce this, it is necessary that inflammation should invade the urethral wall in its entire thickness, and cause an infiltration of plastic fluid, often even of blood, in the spongy tissue. This infiltration, which is especially abundant over a space of one or two centimetres, and which extends, gradually diminishing, in front of and behind this space, becomes organized as the result of a process similar to that of cicatrization, and in its contraction presses together and condenses the tissues with which it is closely united.

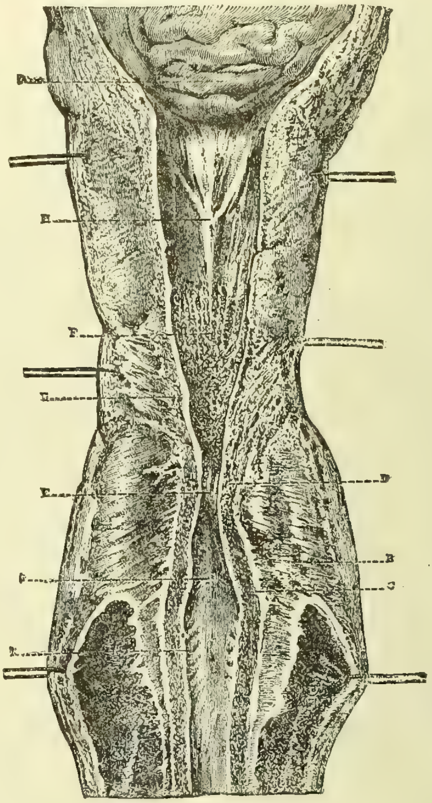
A stricture once established in this way, the following are the alterations which will be met with in a urethra which has been split open lengthwise (Fig. 1326). The canal presents a more or less pronounced diminution in calibre over an extent of three or four millimetres. But these are not really the limits of the stricture. From the most constricted point, and for a distance of about a centimetre in front of and behind this point, the narrowing extends, insensibly diminishing until the canal resumes its normal calibre, in such a way that the stricture, as a whole, presents the appearance of two cones, the two apices of which are blended, or are united by a neck several millimetres long. The posterior cone is ordinarily more expanded than the anterior, in consequence of the excentric pressure exercised by the stream of urine against the walls of the canal; and sometimes it is even transformed into a sort of pocket. The mucous membrane which covers the constricted portion is pale, thickened, and firmly adherent to the subjacent tissues, from which it is impossible to separate it; it is altogether inextensible when an attempt is made to stretch it transversely. The external surface is often smooth; at other times it has a velvety, uneven aspect, which results from the considerable epithelial proliferation which takes place at this point. This coating may sometimes be lifted up at its edges, when there is exposed a perfectly smooth surface, covered with smaller and more adherent epithelial cells. The spongy body has lost its reticulated appearance; its meshes are infiltrated with a yellowish or grayish material, which gives the parts the appearance of a fibroid tumor, traversed by the contracted urethra, and afterwards, in proportion as the organization and contraction advance, that of a narrow ligamentous band. In front of and behind the constricted portion, the urethral tissues resume little by little their normal character; behind it, however, the mucous membrane is often red, softened, and furred, occasionally even ulcerated in some places.

Fig. 1325.



Inflammatory stricture in its lightest form. (After Voillemier.)

Fig. 1326.



Inflammatory stricture in an advanced stage: E, narrowest portion; F, posterior cone, with alterations in mucous membrane; G, anterior cone; D, infiltrated, spongy tissue, most retracted at the seat of stricture. (After Voillemier.)

Microscopic examination reveals at the point of stricture, in addition to the epithelial proliferation of which I have already spoken, a connective-tissue new formation, which begins in the mucous membrane and extends thence to the whole thickness of the walls of the urethra. The development of epithelium is often abundant enough to sensibly diminish the calibre of the canal; further, the most superficial cells, as they exfoliate, become necrosed and mingle with the products of secretion in the glands, giving rise to the discharge which is so often seen in individuals who have strictures of the urethra. But it is in the connective-tissue new formation that the essential element of the coarctation is to be looked for. There is produced, either by diapedesis or by multiplication of the connective-tissue corpuscles, a cellular infiltration, which, when it takes place rapidly, may give rise to real abscesses, but which, when the process is slow, ends in organization of the exudate and its transformation into perfect connective tissue. In time this new-formation tissue, being in great part re-absorbed, dries up and shrivels, in such a way that all the tunics of the urethra, including the mucous membrane, are affected with atrophy, and that at the point of stricture the walls of the canal are thinner than in the healthy parts (*atrophic stricture* of some authors).

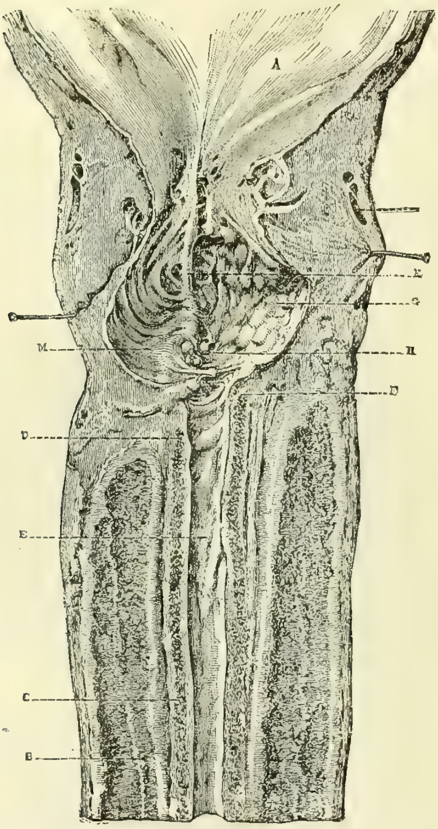
To sum up, the following is the way in which the mode of development of an organic inflammatory stricture is to be regarded: the essential element is the connective-tissue new formation, having for its point of departure the inflamed mucous membrane, and extending thence to all the tissues which constitute the walls of the urethra. This connective-tissue new formation is accompanied, on the side of the surface of the mucous membrane, by an active proliferation of epithelium, with necrosis of the most superficial cells, which give rise to the discharge which is symptomatic of stricture. In regard to the connective-tissue new formation, it consists at first in an infiltration of the tissues with new connective-tissue cells, originating either in a blastema (*plastic lymph* of the older writers), or by proliferation of the normal connective-tissue cells, which is followed by organization into true connective tissue of these new elements, and finally, by retrogression, contraction, and even atrophy of this connective-tissue new formation. Although this connective-tissue new formation plays, as we have just seen, the principal part in the genesis of inflammatory strictures, yet there is another agent which must be taken into account: this is a vital modification of the elastic and muscular elements which enter into the composition of the urethral walls. To their physiological and intermittent contraction succeeds, by means of inflammation, a pathological and persistent contraction, which manifests itself for example, as we shall see hereafter, when a stricture which has been dilated to the point of admitting the passage of a bougie of large calibre, returns in forty-eight hours to its previous state.

It remains, in order to complete this account of inflammatory stricture, to say a few words in reference to certain other conditions which may be met with in cases of this kind. Often the infiltration is limited to one of the urethral walls, usually the lower, on a level with the bulb. The induration then presents itself in the form of irregular patches of small extent, projecting but slightly into the canal. Although there is then a true stricture, yet micturition is but little hindered, on account of the dilatability of the portion of wall which remains healthy. In other cases the induration occupies the whole circle of the urethra, but the degree of constriction varies at different points, whence the formation of a sinuous track of which the orifice is excentrically situated. In other cases, again, the urethra is constricted in a length of from three to five centimetres, but the constriction is more marked at certain points, and several strictures may be supposed to exist when really there is but one. Finally, in certain individuals who have had several attacks of urethritis, the urethra may be constricted throughout its whole extent. In a case of this kind observed by Voillemier (Fig. 1327), the width of the canal at some points did not exceed four or five millimetres; its surface was mammillated from the unequal thickness of plastic infiltration; the shrunken spongy tissue was transformed into a very narrow, yellowish band; and it was only in the gland and bulb that any portions which were healthy and still permeable to blood could be recognized. The cavernous bodies are but rarely invaded by deposits of plastic material, which then occurs in the form of irregular bands, or of little kernels of size varying from that of a grain of rice to that of a large pea.

(2) *Cicatricial Strictures.*—These strictures, as I have indicated, follow *ulcerations* or *traumatisms.*

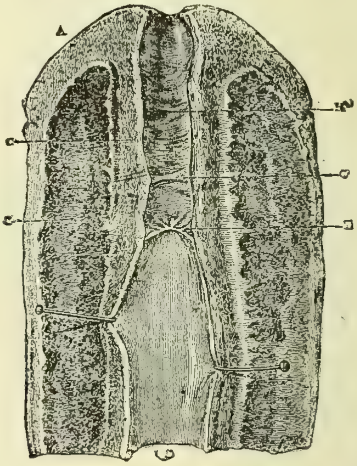
Ulcerations of the urethra are generally superficial, involving only the mucous membrane and the submucous cellular tissue, and only very rarely attacking the spongy tissue. The resulting strictures vary notably with the seat and the nature of the ulcerations. Ulcerations in *acute urethritis* are extremely rare, and are situated almost exclusively in the foramina which exist in the upper surface of the canal, and two or three centimetres from the meatus. They give rise to very small cicatrices, one or two millimetres in diameter, slightly depressed, and which in contracting draw upon the neighboring mucous membrane. (Fig. 1328.) The latter becomes puckered on each side, and finally forms, in the most pronounced cases, a sort of diaphragm, open at its centre. Such a stricture, when single, offers but a slight obstacle to micturition, as a valve of this kind falls down before the stream of urine. But usually this alteration coexists with a more or less extensive organic stricture.

Fig. 1327.



Inflammatory stricture occupying almost the whole length of the urethra. (After Voillemier.)

Fig. 1328.

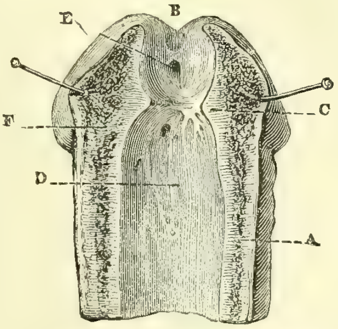


Cicatricial stricture. (After Voillemier.)

Chancroidal ulceration may be met with anywhere in the course of the canal, but its seats of predilection are the meatus and the fossa navicularis. Even when it does not extend to the whole circumference of the mucous membrane of the urethra, it always occupies a portion large enough to materially diminish the calibre of the canal. If the urethra be divided longitudinally (Fig. 1329), the cicatrix is seen to have the shape of a triangle, the apex of which protrudes into the canal, while its base is hidden in the spongy tissue. It is made up of fibrous and cicatricial tissue. The adjacent part of the spongy body is pale, but slightly vascular, and its internal layers participate in the formation of the cicatrix. There is not found here that diffuse infiltration which I have mentioned as being present in strictures of inflammatory origin. The constriction is abrupt, and on each side of the obstruction the urethra quickly resumes its normal characteristics.

I will mention, only to recall it, the third variety of ulceration admitted by Voillemier, a very rare variety, peculiar to the prostatic urethra, and which is observed only in old men in whom the prostate has undergone an increase in size. The two lateral lobes, which are most commonly affected with hypertrophy, are applied one against the other in a vertical direction. If, under these conditions, the mucous membrane which covers these lobes becomes inflamed and ulcerated, adhesions are formed, and an actual fusion occurs between the two lobes, leaving only a narrow passage at the lower part of the canal. Here the mechanism is altogether different from that which we have hitherto studied; we have not to do with a contraction of the walls of the urethra, but only with their apposition and adhesion.

Fig. 1329.



Cicatricial stricture following chancroid.

Strictures which follow traumatic lesions are much more common than strictures consecutive to ulceration, and they are found to be situated preferably in the bulbous and membranous regions; a fact which is explained by the causes which give rise to them—falls upon the perineum, or the action of foreign bodies introduced into the urethra. In the membranous region, the tissues of which do not readily yield to extension of inflammation, the cicatrix is ordinarily limited, almost linear. In the bulbous portion, on the contrary, inflammation developed by traumatism is very easily propagated to the spongy tissue, a plastic infiltration results, and the stricture produced is both inflammatory and cicatricial. It is rare that the cicatrix occupies the entire circumference of the canal; we have seen, indeed, that in rupture of the urethra, even in very extensive ones, there almost always remains a little tongue of sound tissue on the upper wall. But even when the rupture has been complete, the stricture is always thicker on the lower wall.

In the commonest cases, in which the rupture is accompanied by a more or less deep contusion, the canal is found to be included in a more or less thick, fibrous mass. On its internal surface there is observed a large cicatrix, ill-shapen, traversed by tough, elevated, or irregularly arranged ridges; while externally the fibrous mass extends downwards to the skin, and ascends on the other hand to the cavernous bodies, a small part of which it involves. The alterations are sometimes so extensive, the contraction of the fibrous tissues so pronounced, that a bending and shortening of the penis is the result.

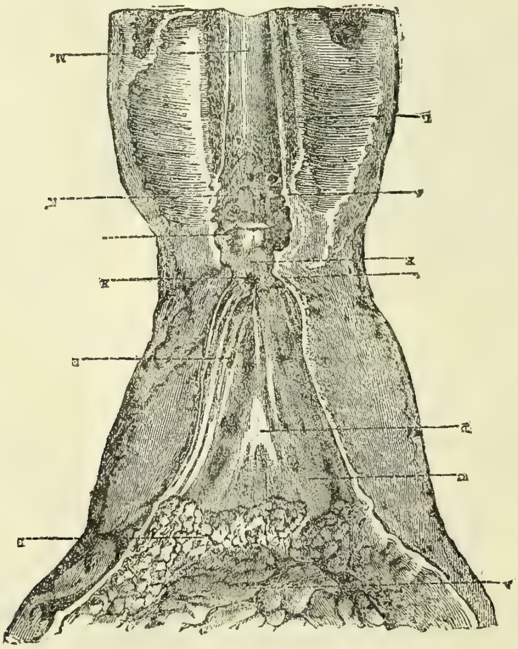
It may be asked, in consideration of these facts, if strictures of the urethra can advance to complete occlusion? Most frequently this is only seemingly so; there is only a temporary occlusion, due to swelling of the mucous membrane, or to a fragment of gravel or to inspissated mucus which has blocked up the narrow passage which had remained permeable. But it is well to recognize that, contrary to the opinion held by some surgeons, complete occlusion may be produced, when fistulæ have been formed which permit a ready escape of urine to the exterior. Voillemier has had the opportunity to observe six examples of this kind, and analogous cases have been reported by Charles Bell, Bérard, Thompson, and some other surgeons. This occlusion results, not from incessant contraction of the stricture, but from the inflammation which necessarily accompanies the formation of fistulæ, and which is propagated to the strictured part, robbing it of its epithelium, and permitting the apposed surfaces to contract adhesions and become agglutinated. What proves this, is that occlusion begins in front of the fistulæ and very rarely extends backwards. The rest of the canal, although not traversed by the urine, preserves its permeability, and almost its normal calibre. The portion thus obliterated is transformed into a fibrous cord, in which no trace of its original structure is found.

There remains, to complete the pathological anatomy of strictures of the urethra, the examination of a certain number of subsidiary questions, relative to their number, their situation, their length, and their general disposition.

The *number* of strictures is variable. According to Ducamp, it is usually one or two, rarely four or five. Hunter has met with six, Lallemand eight, and Leroy d'Étiolles eleven. But it is in the living that these authors have established the existence of so considerable a number of strictures. On the cadaver Voillemier has usually found only one, sometimes two, never more than three. It is possible, in certain cases, to be convinced of the presence of an indeterminate number of strictures, when in reality there is only a single stricture, occupying the whole length of the canal, but more pronounced at certain points.

Length.—In certain altogether exceptional cases, the urethra is strictured in almost the whole of its extent: most frequently the strictures are short, and their length varies from a few millimetres to one or two centimetres. These figures are, however, purely approximative; for it is very difficult,

Fig. 1330.



Traumatic stricture. (After Voillemier.)

even on the cadaver, to determine with precision the point at which the alteration begins and that at which it ends.

Orifice and Track.—The anterior orifice—the only one which is of interest to the surgeon—is sometimes situated in the axis of the canal, sometimes placed at the side, and nearer to one wall than to the other. Sometimes it is large and funnel-shaped; in other cases it is very narrow, and partly concealed by a fibrous ridge or a fold of the mucous membrane, which sometimes makes the introduction of a bougie impossible. When the orifice is central, the tract which lies behind it is ordinarily rectilinear, with smooth and regular walls. But when it presents a distorted cicatrix, this tract is sinuous, zigzag, and covered with fibrous ridges, which circumscribe little anfractuosities, several millimetres deep, and large enough to admit the beak of a small sound. (See Fig. 1330.) We shall soon see that inflammatory and cicatricial strictures of the urethra are the point of departure for accidents and complications which are often very serious. Surgeons are familiar with the lesions of the kidneys and bladder which are occasioned by every obstruction to the free exit of urine, and which have been considered in other portions of the work.[1] The complications which may supervene on the part of the urethra, such as *urinary sinuses or pouches*, *urinary abscesses*, *fistulæ*, *and infiltration of urine*, will be described hereafter.

Symptomatology and Diagnosis.—Strictures of the urethra present three orders of symptoms, which are ascertained from the history of the patient, from the functional disorders of the urinary apparatus, and finally by direct examination of the urethra.

(1) When a patient who complains of some disturbance of urination admits, as part of his *history*, the occurrence of one or several attacks of gonorrhœa, a contusion or a wound of the perineum, a syphilitic ulceration of the meatus, or a hemorrhage caused by the passage of a calculus, the introduction of a foreign body, or a troublesome catheterization, one may almost surely diagnosticate a stricture of the urethra, the existence of which will usually be confirmed by direct examination.

(2) The *functional disturbances* proper to stricture of the urethra are very variable according to the degree and age of the stricture. For a longer or shorter period a stricture may remain latent, with nothing to make the patient suspect its existence; but after a while he notices that his urine escapes with a sort of hesitation, that it is projected only a short distance from the meatus, that the stream has become smaller, and that the length of time occupied in urinating is greater than formerly. This is not all. When the patient has finished urinating, he has a sensation of fulness in the perineum, resulting from the presence in the canal of a certain quantity of urine, which eventually escapes and soils his clothing. In some cases there occurs a sero-purulent discharge from the meatus, which the patient attributes to a return of his old urethritis, and for which he often comes to ask the advice of a surgeon. So one should always be suspicious of these slight and painless discharges, which are symptomatic of a stricture, and which are due, as I have said, to a superficial exfoliation at the strictured point.

The disorder, left to itself, becomes daily more pronounced, and when once it has reached its extreme degree it presents itself with the following characteristics: the patients have an incessant desire to urinate, which it is impossible to satisfy, and it is only at the cost of most energetic efforts that they succeed in expelling their urine drop by drop. They often attempt to overcome the obstruction caused by the stricture by resorting to different artifices. Some pull upon the penis, others plunge it into hot or cold water, or introduce a bougie, or any other foreign body into the anterior portion of the urethra, with the object of provoking contraction of the bladder by reflex action; finally, some patients squat, as if at stool, and contract all their muscles violently. In the midst of these efforts, the penis being in a state of semi-erection, flatus and fecal matter escape from the anus; various complications may likewise be produced, such as prolapsus, hemorrhoids, and hernia, but as only a very small quantity of urine flows, and as the bladder is far from being emptied, a new desire to urinate is soon felt, and the whole scene which I have just described is renewed.

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[1] See p. 343, and Vol. V. p. 1088, *supra*.

A peculiar symptom, which is sometimes observed at an advanced period of the disorder which we are considering, is *incontinence of urine.* The almost incessant efforts which the patients are forced to make, provoke a more or less pronounced atony of the sphincter of the bladder. The neck of the bladder being then constantly open, the dilated prostatic and membranous portions of the urethra form with the bladder a single cavity, in which the urine accumulates, while the excess filters night and day through the strictured part.

To these various troubles of micturition must be added some analogous symptoms which are quite frequently observed in connection with the genital functions, in individuals affected with stricture of the urethra. Besides the diminution of sexual desire and the complete absence of erection complained of by certain patients, ejaculation is sometimes painful, and is more or less hindered by the presence of the stricture. The spermatic fluid is not projected, but dribbles out, part of the fluid flowing backwards from the stricture, and even into the bladder. In cases of very tight stricture, fecundation may even be rendered impossible. Finally, coitus itself may be hindered in certain cases of traumatic stricture, in which the corpora cavernosa are invaded by cicatricial tissue, and are subjected during erection to more or less marked distortion.

(3) The symptoms which have just been enumerated, are no doubt of great importance; but, since the greater part of them may be met with in other affections of the urinary passages—in spasm of the urethra and of the neck of the bladder, and in hypertrophy of the prostate—it is indispensable, either to establish the diagnosis or to obtain precise notions as to the character of the stricture, to make a *direct examination* of the urethra.

A large number of instruments have been devised for this purpose. I shall only mention *wax bougies*, which once enjoyed some favor, and with which it was pretended to take an impression of the stricture, and thus to acquire absolutely accurate information about it. But this precision was only apparent, and it was soon seen that this procedure gave in reality only untrustworthy results, so that it has been abandoned with good reason.

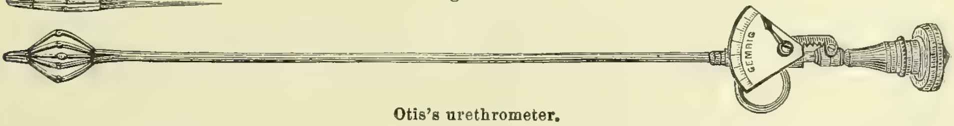
The endoscope of Desormeaux might, in some cases, furnish useful information for the diagnosis of strictures of the urethra; but this instrument is at present almost completely neglected. Nowadays, no instrument but that which I have described under the name of *bougie-à-boule* (bulb-pointed bougie) (Fig. 1305, p. 421) is employed. One with a large bulb is to be used first; it is to be very gently insinuated into the urethra, great care being taken to stop at the first obstacle which is encountered. The length of the portion introduced, measured from the point of the bulb, represents the distance between the commencement of the stricture and the meatus. This first point acquired, an attempt is to be made to determine the degree of narrowness of the stricture, and for this purpose an effort is made to pass it with bulbous bougies, using each time a smaller one, until one is found which passes without force through the strictured portion. By measuring the diameter of the bulb (which is easily done by means of gauges made for this purpose) the calibre of the stricture is ascertained. Finally, with the same *bougie-à-boule* which passes the stricture, the length of the latter may be determined by a very simple procedure. If, after having passed the stricture with the *bougie-à-boule*, this be gently withdrawn, its projecting shoulder, which is set almost perpendicularly to its axis, is arrested at the point where the coarctation ends. By measuring the length of the bougie introduced, from the base of the shoulder, the distance between the deep orifice of the stricture and the meatus is learned. The distance between the anterior orifice and the meatus being already known, it is only necessary to subtract the latter quantity from the former, to get the total length of the strictured portion. Thus, for example, if the first measurement, from the meatus to the anterior opening of the stricture, were thirteen centimetres, and the second measurement, from the meatus to the posterior opening, were fourteen and a half centimetres, the conclusion would be that the length of the stricture was a centimetre and a half.

By the mode of exploration which has just been described, therefore, the position, length, and degree of narrowness of a stricture may be learned. It is obvious that the *bougie-à-boule* makes it possible, according as it is arrested once or encounters several obstructions, to recognize whether there is but one stricture or several; and in the latter case, the various manœuvres already indicated will furnish data for determining the seat, the length, and the narrowness of each stricture.

In addition to these data, Voillemier has thought that it would be possible to recognize certain excentric strictures, limited to one part of the circumference of the canal, by making use of a bougie terminated with a half-bulb. Having reached the level of the strictured point, the surgeon, by turning the bougie between his fingers, could ascertain the wall upon which the constriction was placed.

I have supposed, up to this time, that the stricture is permeable by the *bougie-à-boule*; it will be understood that, in cases in which this condition does not exist, the data furnished by the *bougie-à-boule* are limited to establishing the situation of the stricture, and that it becomes impossible to determine what is the extent of the coarctation, and whether or not others exist, situated more deeply. Further, it is well to know that, while quite exact notions in regard to the number, the seat, the length, and the degree of narrowness of strictures of the urethra, may be arrived at by means of the *bougie-à-boule*, these notions are only approximative, though perfectly sufficient for the wants of practice. [If greater accuracy is needed, Dr. F. N. Otis's urethrometer (Fig. 1331) may be employed.] I have elsewhere dwelt already upon the signs which make it possible to distinguish between a true coarctation of the urethra and spasm of this passage, or of the neck of the bladder, as well as hypertrophy of the prostate. These two affections are, indeed, the only ones which could be confounded with organic stricture; all the more because, in the first especially—contracture of the neck of the bladder and of the urethra—in addition to the observation of functional troubles analogous to those of organic stricture, the results furnished by exploration with the *bougie-à-boule* seem identical at first sight, and require to be carefully interpreted if one wishes to avoid error.

Fig. 1331.



Otis's urethrometer.

Complications.—Some strictures may remain stationary without offering any serious hindrance to micturition; for example, when there is simply a ridge of mucous membrane, or when the alteration occupies only a portion of the circumference of the canal. But this is exceptional. In the great majority of cases, strictures become more and more tight, and the functional troubles which they occasion grow more and more intense. Then there may supervene a certain number of more or less serious accidents or complications, which modify the regular course of the stricture. These complications usually appear in individuals who have presented, for a longer or shorter period, troubles of micturition which are characteristic of the presence of a stricture; some patients have even been previously under treatment, and inform the surgeon as to the nature of their disease. Yet it should be known that, in certain cases, and in certain individuals who are negligent of their health or who are unobservant of themselves, the first manifestation of stricture of the urethra consists precisely in the appearance of one of the complications which remain to be described. I have seen several instances of this kind.

Among the complications which may supervene in the course of a stricture of the urethra, some are acute and abrupt in their appearance; others, on the contrary, affect a slow and insidious course.

In the first rank of acute complications should be placed *retention of urine*, coming on suddenly in a person affected with stricture of the urethra. This retention, which often follows excessive fatigue, or an error of regimen, has different causes: sometimes it results from obstruction of the lumen of the stricture by a foreign body (calculus, inspissated mucus); sometimes it is due to inflammatory or congestive swelling of the urethral mucous membrane; sometimes, finally, it is to be attributed to a reflex spasm of the neck of the bladder, developed under the influence of an irritation starting from the stricture. Further, this retention is most commonly facilitated by secondary changes in the vesical walls, which, as I have many times repeated, supervene more or less rapidly in all cases in which there is an obstruction to the normal flow of the urine. I confine myself to mentioning this complication of strictures, which is considered in another article in connection with retention of urine generally.[1]

Another complication, much less common but more serious, consists in rupture of the urethra behind the stricture. *Spontaneous ruptures* of the urethra, which are only rarely observed in consequence of the engagement of a calculus, are more common in the case of strictures which have reached an extreme degree of narrowness; and this difference is explained by the fact that, in the case of a calculus blocking up the urethra, the walls of the canal are healthy, whilst in the case of an old and very narrow stricture, they have undergone more or less considerable changes which predispose them to rupture. Terrillon, having made some experiments with the object of estimating the resistance of the normal urethra to distension, has always seen rupture produced by a pressure of from one and a half to two atmospheres; from which it is to be inferred that an effort at micturition, however violent it may be, cannot burst the urethra behind an obstruction if the canal have not undergone a certain degree of alteration. Hunter, whose opinion has been adopted by the majority of surgeons, considered rupture as the result of mortification or ulceration of the walls of the canal, without taking into account, in this explanation, either the pressure of the urine against the obstruction or the energetic action of the bladder. Voillemier, relying upon the results furnished by examination of numerous pathological specimens, first demonstrated that the lesions ordinarily met with behind a stricture, were far from having the gravity which had been previously assigned to them. Ulcerations may exist, often very numerous, but small, superficial, limited to the mucous membrane, and constantly resting upon an indurated base, impermeable to liquids. The following, in the opinion of Voillemier, is the way in which the complication is produced: as soon as a stricture has reached a certain degree, the urine, being unable to escape freely, tends to dilate the urethra above the obstruction. In this way a sort of pocket is formed, in which the urine remains and is altered, and the walls of which inflame, become friable and less resistant, and end by bursting under the strain of the efforts which the patient makes in order to evacuate his bladder. This theory of the mechanism of spontaneous rupture of the urethra, following stricture, already imperfectly recognized by Charles Bell and Civiale, has been fully adopted by Sir Henry Thompson.

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[1] See pp. 399 *et seq.*, *supra.*

In regard to the situation of these ruptures, it may be said, in a general way, that they occur immediately back of the stricture, and consequently oftenest at the junction of the bulbous and membranous portions of the urethra. The tear almost always takes a longitudinal direction, parallel to the axis of the canal. Its length varies from four to ten millimetres; its breadth from three to four. In some cases, however, there is found at the autopsy a considerable loss of substance, sufficient sometimes to effect the complete disappearance of the strictured part. Then there is evidently a mortification of the walls of the urethra, consecutive to the rupture, properly so called. Very rarely the rupture occupies the lower and median walls of the urethra, much more frequently it is situated on the side. Finally, it is traumatic strictures which are most prone to be accompanied by the complication which is under consideration; this is explained by the course of these strictures, which attain their highest degree of intensity with extreme rapidity.

Among the symptoms of pathological rupture of the urethra, there is one which is really pathognomonic, and which makes it possible to formulate the diagnosis immediately; this is the peculiar sense of comfort, the instantaneous relief, spoken of by a patient affected with stricture, and who an instant before was exhausting himself in futile efforts to satisfy his inclination to pass water. But this sense of comfort is followed by acute pain, recurring and becoming burning at each micturition, and soon attended by a considerable swelling of the perineum and circumjacent parts, and by high fever—in a word, by all the characteristic symptoms of urinary infiltration, which, if it does not lead to the death of the patient, often leaves behind urinary fistulæ.

In addition to the acute complications which I have just mentioned, and which manifest themselves locally, strictures of the urethra are quite frequently the cause of febrile outbreaks, which come on suddenly, especially in consequence of attempts at exploration or treatment, and are capable of carrying off the patient in a few hours. I shall speak hereafter in detail of this grave complication, in a section devoted to *urinary fever.*

Finally, I have referred, in addition to the acute complications of stricture of the urethra, to a certain number of complications, the progress of which is slower, often insidious, and which may be designated by the name of *chronic complications.* I restrict myself to mentioning them here, reserving their special study for a subsequent portion of this article. Among these chronic or subacute complications, some are *local*, like urinary abscesses and urinary sinuses or pockets; others are *general*, having no feature peculiar to strictures, and being encountered in all cases in which, in consequence of obstruction to the flow of urine, the bladder is incompletely emptied. These last complications, which are usually the result of a cysto-pyelo-nephritis, will be studied under the head of urinary fever.

Prognosis.—From what has been said, it is to be seen that stricture of the urethra should always be looked upon as a grave affection: grave in itself, since it exposes the patient to a whole series of local or general complications, capable of causing death; grave also in regard to the treatment which it demands, treatment which may be dangerous even in the most benign cases. Finally, it cannot be too often repeated that the cure of stricture of the urethra is never radical and final, no matter what method of treatment may be employed; and that relapses will inevitably occur, if care be not taken to maintain the results obtained, by means of treatment continued, so to speak, indefinitely. In conclusion, I will add that the character of a stricture has an influence on the prognosis. Traumatic strictures are much the most serious, as much on account of the rapidity of their course and the complications which they set up, as in regard to their treatment, since they are amenable to only the more dangerous procedures.

Treatment.—There are three principal methods of treating strictures: *cauterization*, *dilatation*, and *urethrotomy.*

(1) *Cauterization.*—Employed by the surgeons of the sixteenth and seventeenth centuries for the purpose of destroying so-called *carnosities*, cauterization was practised with astringent, but hardly caustic, medicaments, so that it is reasonable to attribute the successes which it gave, to the dilatation produced by the bougies used to introduce the supposed escharotics into the canal. Then, toward the end of the eighteenth century, dilatation was substituted for cauterization by Desault and Chopart. This method, indeed, was about to be completely abandoned, when Hunter and Everard Home came to restore it to honor by substituting, for the more or less inert substances employed by the ancients, the fused nitrate of silver. A caustic substance brought into contact with a stricture acts in two different ways: sometimes, when the cauterization is energetic, it produces a more or less extensive loss of substance, which makes the stricture disappear, but substitutes for it cicatricial tissue; sometimes, when it is less profound, it determines in the subjacent tissues more or less intense inflammatory phenomena, which modify the mode of vitality of the parts, paralyze the contractile fibres of the urethra, diminish momentarily their resistance, and render the stricture more easily dilatable.

Cauterization may be practised according to two different methods: 1st, from before backwards; 2d, laterally. Hunter, who by his writings and his practice contributed most to the general adoption of *antero-posterior cauterization*, used a bougie of ordinary wax carrying at its extremity a fragment of nitrate of silver, which he left in contact with the affected parts for about a minute. He repeated this cauterization every two days, if no accident happened, and had recourse to dilatation as soon as the stricture permitted a bougie to pass. Cauterization was, therefore, for Hunter, only an accessory operation, designed to prepare for and facilitate dilatation. Everard Home, a pupil of Hunter, regarded it altogether otherwise, and used the armed bougie, not to prepare the way for dilatation, but to destroy the stricture: the bougie was pushed up to the obstruction and gently pressed against it for a minute or two; and this operation was repeated every two days until the moment when, the stricture having disappeared, the bougie penetrated freely to the bladder. This blind and brutal procedure, which exposes a patient to the gravest accidents, has long been justly abandoned. On the contrary, antero-posterior cauterization practised according to the method of Hunter, may be of great service in certain cases of stricture, very difficult to pass either by reason of the irregular character of the opening or of the track, or because of the extreme sensitiveness of the mucous membrane and of the spasmodic contraction which is excited by the least contact of a foreign body with the affected parts. A few light cauterizations may cause this hindrance to disappear, and may render easy a dilatation previously impossible.

Lateral cauterization, devised by Whately, was chiefly put into practice by Ducamp, and then perfected by Lallemand, Ségalas, and some other surgeons. It consists in acting upon the stricture, not from before backwards, but from within outwards. This method, besides the fact that it is applicable only to not very tight strictures, has the great drawback of acting only by producing a loss of substance, and thus transforming a simple inflammatory stricture into one which is cicatricial, and still more contractile than the first.

Certain authors, charging to the account of the substance employed the almost constant failure of cauterization, have proposed to replace the nitrate of silver with caustic potassa, on the hypothesis that alkaline or neutral cicatrices alone could secure, on account of their softness, a durable cure. This idea has been the point of departure for a new method of cauterization, by the *chemical galvano-cautery*. This method, which, in reality, differs little from urethrotomy, and the conditions of application of which have been principally formulated by Mallez and Tripier, appears to have given a certain number of successes; but it requires machinery complicated and hard to manage, and, equally with the other procedures, it exposes the patient to a relapse after a short interval.

In conclusion, cauterization should not constitute a general method of treatment. It may be employed in certain determined cases, but only as auxiliary to dilatation. It should never be deep and destructive, and the preference should be given to cauterization practised from before backwards.

(2) *Dilatation.*—We have seen that the older surgeons, at the same time that they attempted to destroy, with the help of cauterization, the so-called carnosities which they considered the most ordinary cause of dysuria, introduced into the canal bougies, lead sounds, etc., and thus effected dilatation without knowing it. This method, however, did not immediately succeed the knowledge of the lesions which constitute strictures, and for nearly a century escharotic and medicated bougies were still employed. Benvoli first, in 1724, elevated the treatment of strictures by dilatation to a method, and his practice was followed by Col de Villars, Astruc, and a large number of other surgeons. Finally, Hunter formulated better than had been done before him the anatomical characteristics of strictures, and the mode of action of bougies.

There are two methods of dilatation; one *inflammatory*, the other *mechanical.* The first includes *atrophic* dilatation and *ulcerative* dilatation. The second includes *forced catheterization* and all the procedures of *rapid dilatation.*

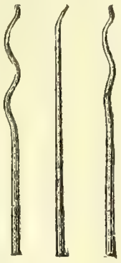
1. *Inflammatory Dilatation.*—Voillemier has given this name to a series of organic phenomena which are provoked in the walls of the urethra by the contact of a foreign body, and which lead to atrophy and resorption of the parts constituting the stricture. When a foreign body is introduced into the midst of the tissues, it sets up there a series of actions which tend to its elimination. There is at first an irritation, expressed by contracture and spasm, and soon followed by more or less marked relaxation. Then follow other phenomena, more slow, more continuous, and more profound. The blood flows into the vessels; new ones are developed, which invade and rarefy the tissues; and around the foreign body a pyogenic membrane is organized, which seems to retire before it to make room for the pus which it everywhere secretes. The introduction of a bougie into a stricture, which it fills without causing laceration, is accompanied by absolutely analogous phenomena. There is felt, at the end of a few minutes, a certain difficulty in withdrawing the instrument. Soon the spasm disappears, and movement of the bougie becomes easy again. Afterwards a muco-purulent discharge is established in

the canal, and one is surprised to find that the stricture permits the passage of a much larger bougie. The enlargement obtained is evidently not the effect of the pressure exercised by the bougie, since this was in nowise tightly grasped; it is the result of the inflammation excited in the stricture by the presence of the foreign body. By the action of bougies of gradually increasing size, the work of resorption continues, the contractile elements *atrophy*, and the urethra ends by resuming its normal calibre. If, instead of proceeding with gentleness, a very large bougie is used immediately, a violent inflammation is developed, followed by *ulceration* of the mucous membrane and by destruction of the stricture. This is why I have admitted two methods of inflammatory dilatation, one atrophic, the other ulcerative.

Mechanical dilatation is very different from the preceding. Its object is to violently separate the walls of the urethra, and to tear the stricture open without previous inflammatory action. Nevertheless, this inflammation is produced afterwards, and it has, as we shall see, its share in the cure. In practice, moreover, these two modes of action of dilatation combine and lend a mutual support. Thus it is that when one has succeeded in provoking inflammation of a stricture and resorption of its elements, it is customary to have recourse to mechanical dilatation to distend and to atrophy the fibrous and contractile tissues which enter into its composition. The same is the case in rapid dilatation. A single operation cannot suffice; several must be practised, and in the intervals an active inflammation is developed, which brings most efficacious assistance to the mechanical measures. To practise inflammatory dilatation, instruments are used of such calibre that they play freely in the strictured part, and their calibre is progressively increased. Each of these is allowed to remain in the urethra for three or four days, sometimes for six or seven, until an abundant purulent discharge is developed, the certain indication of an inflammatory action indispensable to dilatation. As soon as the introduction of a bougie of 7 or 8 millimetres has been attained, it is well to give up *permanent dilatation* and to substitute for it *temporary dilatation*, practised either with ordinary bougies or with metallic instruments, and prolonged for months or even for years.

Such is the course which it is proper to follow in simple cases; but numerous difficulties may present themselves, and it remains for us to examine what, in such cases, should be the conduct of the surgeon. The urethra sometimes is in a state of very acute sensitiveness, which renders the introduction or the retention of an instrument absolutely impossible, and which depends either upon a slight inflammation of the mucous membrane at the point of stricture, or upon a spasm resulting from this inflammation. In such a complication nothing succeeds better, according to Voillemier, than the superficial cauterization of which I have previously spoken. Under other circumstances the stricture is so tight that the bougie penetrates it for a certain distance without being able to pass it. It is proper to act in such a case as if the bougie had passed. After having left it in place for several hours, it is removed, and new attempts are made on the morrow and the days following; almost always one can in this way succeed in getting through the stricture without doing violence to the canal. At other times it is impossible not only to pass the stricture but even to engage the extremity of the bougie in it. A number of procedures and artifices have been devised to triumph over this difficulty, which usually depends less on the narrowness of the channel than on the excentric situation of the opening; bougies are used, the extremities of which have been bent, twisted, shaped like bayonets, and coated with collodion (Fig. 1332); bougies of whalebone, uniting to the most extreme delicateness sufficient rigidity, but dangerous on account of this very

Fig. 1332.



Elbowed and spirally twisted bougies.

rigidity, which enables them to traverse the mucous membrane and burrow into the submucous cellular tissue, when they are believed to be engaged in the strictured portion.

Another measure consists in introducing into the canal first one bougie, and then passing alongside of it one or several others to which the first serves as a guide. The bladder has likewise been successfully penetrated in certain cases, by introducing the bougie at the very moment when micturition was taking place.

Finally, sometimes it is very advantageous to suspend every attempt for several days, prescribing to the patient rest and baths. Very often have I been able in this way to triumph at the first blow, so to speak, over strictures against which all my efforts had previously been futile.

There are certain strictures, the dilatation of which can be easily carried to a certain degree, beyond which it is not possible to go without seeing pain, spasmodic contraction, hemorrhage, orchitis, and sometimes actual attacks of fever supervene. Such accidents ordinarily are the result of too rapid dilatation, and they are avoided by proceeding more slowly. If, however, they persist in spite of these precautions, it is necessary to abandon dilatation and to have recourse to another method of treatment. There is besides a variety of strictures called *elastic* or *contractile*, in which the coarctation is reproduced with extraordinary rapidity as soon as the dilatation is suspended. This difficulty, which is encountered principally in strictures of cicatricial origin, also requires the abandonment of dilatation.

To obtain *ulcerative inflammatory dilatation*, sometimes a bougie is forcibly introduced through the whole length of the stricture, sometimes strong pressure is exercised with the point upon the anterior part of the stricture, which is too tight to be passed. Such a procedure ought to be absolutely rejected, not only because it offers no advantage over atrophic dilatation, which is suited to the same cases, but also because it exposes the patient to most serious accidents. Thus ulceration has been seen to attack and destroy the spongy body, to extend to the corpora cavernosa, and then to determine either a deformity of the penis, resulting from an unavoidable, vicious cicatrix, or even a phlebitis followed by purulent infection and death. In all cases, the almost inevitable consequence of ulceration, even if limited to the mucous membrane and the submucous cellular tissue, is the formation of a cicatrix the extent of which is in proportion to the loss of substance, and the production of a cicatricial stricture always more serious than that which existed before.

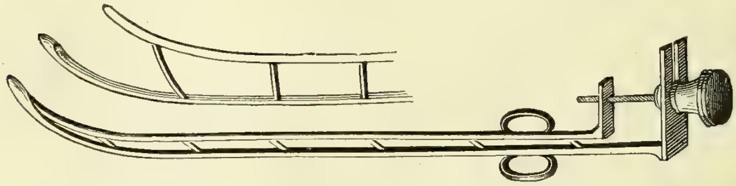
2. *Mechanical dilatation* includes several operative procedures: (*a*) *gradual mechanical dilatation;* (*b*) *rapid mechanical dilatation;* (*c*) *forced catheterization;* (*d*) *sudden dilatation or divulsion;* and (*e*) *forced injections.*

(*a*) *Gradual Mechanical Dilatation.*—This is practised with bougies which are introduced into the urethra at more or less frequent intervals, and the size of which is gradually increased. These bougies should not play freely in the canal, but should penetrate it with slight friction, and be left then for quite a short time, only a few minutes. To effect this dilatation one may employ either more or less voluminous flexible bougies, or metallic sounds called *Sondes de Béniqué.* The series of Béniqué is composed of from thirty-five to sixty pewter sounds, cylindrical in shape, graduated in fifths or sixths of a millimetre. Number 1 has a diameter of four millimetres; the last number, which is the largest, has one of ten. When the stricture is very tight, we commence by bringing it up to four millimetres with ordinary bougies, in order to be able to introduce the first sound. The sittings usually take place every day, but the number of sounds introduced at each of them should vary. At the start only one or two are passed, but afterwards the number may be carried up to four or five, taking care to return each time to the two or three last numbers which have been used the day before, in order to thoroughly prepare the canal to bear a higher number.

This procedure, which is simple and easy of execution, may nevertheless, if it is employed without precaution, provoke spasm of the urethra, hæmaturia, and cystitis of the neck of the bladder. Insufficient in itself, it is of very great utility to perfect the results obtained by other methods. In fine, its mode of action holds the middle place between that of atrophic dilatation, which I have described, and that of true mechanical dilatation, which remains to be spoken of.

(*b*) *Rapid Mechanical Dilatation.*—In this method dilatation is obtained by means of instruments which, after having traversed the stricture, act in the manner of forceps the blades of which are separated. The dilators devised for this purpose by Michelena and Rigaud (Fig. 1333), are composed essentially of two half cylinders of steel, united by means of small, articulated metallic strips, and constituting by their union an ordinary sound of variable dimensions. A screw placed at the extremity of the instrument makes it possible to slide the two halves, one upon the other, in the direction of their length; from this movement erection of the metallic strips results, and separation of the two halves of the sound. The dilator of Perrève is likewise a hollow sound split along its length, but its branches, instead of sliding one upon the other, are separated by means of stylets of different size. It is necessary to have dilators of different size. The complete series is composed of seven numbers: number one is two millimetres in diameter, number seven is five. The stylets are three in number; they have diameters of two, three, and four millimetres. This instrument, which cannot be denied certain advantages, has the disadvantage of not having a form appropriate to that of the urethra. Cylindrical when the halves are side by side, it assumes, as soon as they are separated, an oval form with its large diameter antero-posterior, its small diameter transverse; so that the dilatation, instead of acting in all directions, is exerted only on the lateral walls of the urethra. Charrière has tried to remedy this imperfection by constructing a dilator with four arms, having an antero-posterior diameter equal to the transverse diameter. But the instrument, even modified in this manner, is not capable of dilating the canal evenly. It has also, as well as the original instrument, a certain number of sharp ridges which wound the walls of the canal, so that at each sitting one acts upon a urethra already inflamed by the preceding sittings, thus exposing the patient to most serious accidents. [Fig. 1334 represents the modification of Perrève's instrument known as Holt's divulsor.]

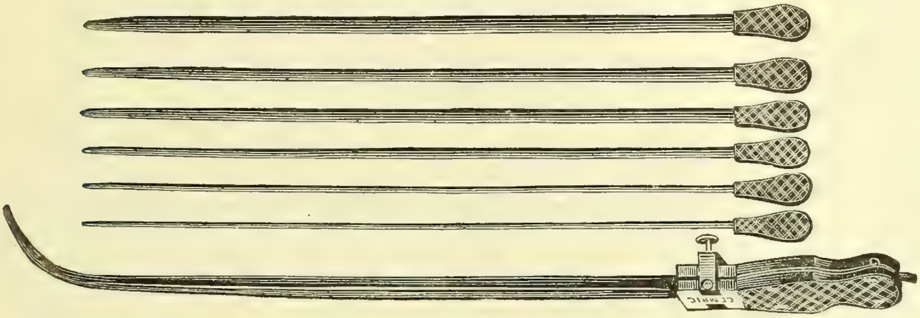
Fig. 1333.



Rigaud's dilator.

With this method may also be classed the procedure devised by Le Fort, and designated by him by the name of *immediate progressive dilatation.* One begins by engaging in the stricture a flexible bougie which has at its outer end a small metallic piece with the thread of a screw cut into it. This bougie is left in place for twenty-four hours, at the end of which time there is screwed to its extremity a conical sound of German silver, the diameter of which is, at its point, that of the flexible bougie, and the largest diameter of which corresponds to number twelve of the scale of Charrière. This sound is then pushed into the canal, at the same time that it propels before it the flexible bougie, which enters and curls up in the bladder. The sound is then withdrawn, and replaced, either the same day or the next by a sound, number 2, then by a sound number 3. This done, nothing more remains but to continue the dilatation of the stricture by means of ordinary bougies of progressively increasing size, and to advise the patient to maintain the cure by passing every day, then every two days, and then every week for several months, a flexible bougie, number 18.

Fig. 1334.



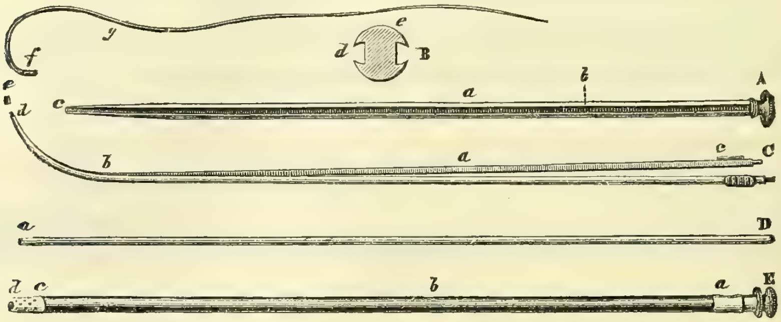
Holt's divulsor.

(*c*) *Forced Catheterization.*—Already employed in the eighteenth century, forced catheterization was specially recommended by Desault, Chopart, Roux, and Boyer. Boyer used for this operation a conical catheter of moderate calibre, with very thick walls, and with a diameter diminishing insensibly from the handle to the further extremity, which terminated in a blunt point. With no other guide than the finger placed in the rectum, this catheter was pushed into the urethra with a force proportioned to the resistance it met with. When once it had entered the bladder, it was allowed to remain for three or four days, and then replaced with a flexible catheter which was changed every eight days, and the diameter of which was progressively increased. It is useless to insist upon the dangers occasioned by such a manœuvre, by which there is a much greater chance of perforating the urethra than of passing the stricture, and which, in spite of the favorable opinion of Voillemier, is now completely abandoned.

The procedure of Mayor differs little from the preceding. Mayor employed seven pewter sounds, six of which were cylindrical in form and of a diameter gradually increasing to nine millimetres; the seventh was conical, and, like Béniqué's No. 1, was four millimetres in diameter at its point. Mayor began by attacking the stricture with the small sound, and pushed into it successively each of the six others. This is another detestable operation, which ought to be absolutely rejected.

(*d*) *Sudden Dilatation or Divulsion.*—Divulsion is an operation which, like the rapid dilatation which I have just described, is applicable only when there is already a certain degree of permeability of the canal. The divulsor of Voillemier (Fig. 1335), which is without contradiction the most perfect of the instruments of divulsion, is composed, 1st, of a conductor made of two narrow blades of steel united at their vesical extremity for a distance of four centimetres, and curved at this part like a catheter; these blades are flat within, convex without, in such a way as to furnish by their union a delicate sound, two millimetres in diameter, split along its length; 2d, of a

Fig. 1335,



Voillemier's Divulsor.—*A*, plunger; *b*, its longitudinal groove; *B*, section of stylet; *C*, guide with its branches (*a*) slightly separated, but united at their beak, where there is a screw for the adjustment of the bougie, *gf*; *DE*, stylet and catheter.

stylet terminating in a conical extremity, solid and cylindrical in all the rest of its extent, and furrowed in its side by two flat, shallow grooves, designed to receive the two blades of the conductor. This groove has the shape of a dove-tailed mortise, so that the blades of the conductor, once engaged, cannot escape from it.

The conductor having been previously introduced into the bladder, its two blades are slightly separated and secured in the grooves of the stylet, which is driven with a single motion into the urethra. The instrument is then withdrawn, a catheter is inserted and allowed to remain for twenty-four hours, and about the tenth or fifteenth day the employment of metallic bougies is begun.

In fear of being unable to introduce a catheter, when once divulsion has been accomplished, Voillemier has had constructed a long stylet (Fig. 1335, *D*), which can be attached to the conductor, and a catheter *E*, open at both ends and capable of sliding along the stylet; but the employment of these last two instruments has never appeared to me necessary.

(*e*) *Forced Injections.*—These injections, of which I shall say but a word, have been recommended as a means of dilatation of strictures by Soemmering, Bruninghausen, Amussat, and Reybard. Injections of oil, such as Soemmering practised, may indeed facilitate sounding, but cannot cure stricture. Amussat had the idea of clearing by forced injections a stricture clogged with mucus or gravel. He made a mistake in wishing to generalize this method. Reybard proceeded in the following way. Either he introduced up to the obstruction a canula, the expanded end of which was closed by a cover with two holes, intended, one to give passage to a bougie, the other to receive the end of a syringe filled with water; or he simply poured into the canula a certain quantity of mercury, the weight of which exerted a strong and continuous pressure upon the walls of the canal. All these methods have been abandoned with good reason.

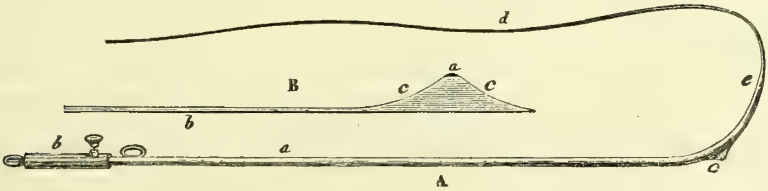
(3) *Urethrotomy.*—Urethrotomy is an operation in which the constricted portion of the urethra is incised. There are two methods of urethrotomy:

one, in which the stricture is incised from within outwards—this is *internal urethrotomy;* the other, in which the incision is made from without inwards—this is *external urethrotomy.*

1. *Internal Urethrotomy.*—The idea of overcoming by means of a cutting instrument the obstruction which is offered to the emission of urine, goes back to the sixteenth and seventeenth centuries; and various instruments, which I will not describe, were devised for this purpose by Ferri, Ambroise Paré, Diaz, and Viguerie. Those of Physick (1795), of Arnolt (1819), and of MacGhie (1823), were much less imperfect; but it is to Amussat that we owe the first urethrotome really meriting the name. It was in 1824 that this surgeon presented to the Academy of Medicine a urethrotome supplied with a conductor, to divide strictures from before backwards; and some time after a scarificator, having for its object the practice of the same operation from behind forwards. Since this epoch a large number of urethrotomes have been devised, among which I will cite those of Leroy d'Étiolles, of Reybard, of Ricord, of Charrière, of Civiale, of Caudmont, of Maisonneuve, and of Voillemier.

The urethrotome of Maisonneuve (Fig. 1336), the most simple, and that generally employed, is composed: 1st, of a curved, grooved tube, from one to three millimetres in diameter and thirty centimetres long, having several millimetres of the outer surface of its internal extremity cut with a screw-thread; 2d, of a delicate, gum-elastic bougie, with a conical point, and bearing on its outer end a small cap, cut inside with a screw-thread which fits very exactly with that of the tube; 3d, of a flat blade, resembling very closely an isosceles triangle, having a blunt apex, cutting sides slightly hollowed, and prolonging by its base the extremity of a metallic stylet, thirty centimetres long, intended to slide in the hollow tube. The extensible portions of the urethra admitting of being lifted up by the blunt angle, the cutting side cannot reach them, and section of the mucous membrane is effected only at points where the calibre of the canal is diminished.

Fig. 1336.



Urethrotome of Maisonneuve.—*A*, complete instrument; *a*, grooved catheter; *b*, handle carrying the blade, *c*, of the instrument; *d*, conductor; *e*, screw, to which the conductor is attached. *B*, blade of the urethrotome, the apex of which, *a*, is blunt; *b*, shaft supporting the blade; *cc*, cutting edges in the shape of a ploughshare.

This, then, is the way of proceeding: the bougie having been previously introduced into the urethra, the grooved tube is screwed to its extremity and pushed into the bladder. This done, the penis is stretched firmly on the canula with one hand, while with the other the stylet is engaged in the groove of the catheter, and driven in so that its blade traverses the whole length of the canal. Then there is nothing left but to withdraw the instrument, and to place in the urethra a catheter which shall be allowed to remain.

Urethrotomy furnishes a satisfactory result only when the stricture is incised through its entire thickness; superficial incisions, even practised at a number of points, do not sensibly augment the calibre of the canal. Likewise, the surgeon, to avoid accidents, ought to incise the lower wall, and as far as possible in the median line.

Urethrotomy may be complicated with serious accidents, which may cause death. *Hemorrhage* always occurs, sometimes abundant enough to endanger the life of the patient. *Urinary infiltration* is but rarely observed, doubtless because of the precaution which most surgeons take, after having incised the urethra, of retaining in it a catheter. In some rare cases the edges of the incision, instead of quickly uniting, as is usually observed, remain separated the one from the other, and there is found at this point a true cavity, which Voillemier, who has seen a number of examples of this complication, has designated by the name of "urethral pocket." Urethrotomy may also be complicated with more or less grave *urinary fever*, sometimes followed by rapid death. Finally *erysipelas*, *phlebitis*, and *purulent infection* have been seen to follow internal urethrotomy, and likewise constitute serious complications of this operation.

Even a large incision of a stricture cannot suffice to restore to the urethra its normal calibre, and it is indispensable, as soon as the operation is ended, to place in the urethra a catheter large enough to fill the canal and to permit the separate cicatrization of the two faces of the incision. This catheter should be withdrawn at the end of forty-eight hours, and the wound left to itself for twelve or fifteen days. At this time the cicatrix is still soft enough not to offer very great resistance to dilatation, without which a relapse would not be long in taking place. This dilatation is practised in accordance with the rule which I have indicated, either with flexible bougies, or, better, with the metallic instruments of Béniqué, taking care always to proceed with extreme slowness.

2. *External Urethrotomy.*—This operation consists in dividing from without inwards—from the skin toward the urethra—the various tissues, the alteration of which constitutes the stricture. The perineal *boutonnière*, with which urethrotomy was long confounded, has no other object but to permit the escape of urine by an incision in the healthy part of the urethra situated behind the affected parts. It is therefore a purely palliative operation, which, as J. L. Petit first clearly showed, cannot effect a cure except when the obstruction is included in the incision.

External urethrotomy, which towards the middle of the eighteenth century enjoyed a certain amount of favor, was energetically combated by Desault, Boyer, and Roux, whose attacks caused it to fall into complete discredit. Some English surgeons, Arnott, Brodie, Liston, etc., endeavored to preserve it from oblivion; but it was Syme who, in 1844, succeeded in calling attention anew to this operation, and securing for it a definitive entrance into practice. Urethrotomy is practised with or without a guide, according as the stricture does or does not admit of the passage of a sound.

(*a*) *External Urethrotomy with a Guide.*—A grooved, curved sound having been introduced into the urethra, and the patient having been placed as for the operation of lithotomy, an incision four or five centimetres long is made in the median line, and the soft parts are divided until the sound can be felt. This done, the point of a bistoury is engaged in the groove, and the stricture is divided through its whole thickness. It then remains only to withdraw the sound, and to replace it with a catheter to be left in the urethra.

(*b*) *External Urethrotomy without a Guide.*—This operation differs from the preceding one chiefly in the difficulty, sometimes insurmountable, which is experienced in discovering the posterior opening of the urethra. The following is the ordinary method of procedure:—

A sound is carried up to the face of the obstruction and held by an assistant. Then an incision three or four centimetres long is made in the median line, laying bare the end of the sound, and an attempt is made to introduce by the anterior extremity of the stricture a probe or a grooved director, by the help of which the stricture may be divided through its whole extent. This done, a catheter is introduced into the bladder and fastened in. But there are cases in which the discovery of the constricted orifice presents such great difficulty that the most skilful find themselves balked. For cases of this kind, a certain number of modifications of external urethrotomy without a guide have been introduced, described under the names of *retrograde catheterization*, *excision* or *resection* of strictures, and *collateral urethrotomy;* concerning each of these I will confine myself to saying a few words.

Retrograde catheterization, practised for the first time in 1757, by Verguin, a surgeon of Toulouse, consists in introducing a catheter into the urethra through a pre-existent fistula of the bladder, consecutive to puncture of this viscus. This manœuvre, to which a number of surgeons have had recourse, offers, as may be understood, the immense advantage of admitting of the certain finding of the posterior end of the urethra. But it requires the presence of a hypogastric vesical fistula.

Sédillot formerly expressed the opinion that, in the absence of a pre-existing fistula, if in the course of an external urethrotomy, undertaken for an impassable stricture, it were found impossible to discover the posterior end, the surgeon would be justified in doing suprapubic cystotomy at once, in order to practise retrograde catheterization.

In an extremely complicated case, of which I have published an account,[1] after having failed the first time in the search for the posterior end of the urethra, I decided to have recourse to this extreme measure; I opened the bladder above the pubis, and succeeded in introducing by the urethro-vesical orifice a sound, which, being made to protrude in the perineal wound, enabled me to re-establish the continuity of the canal. The operation was followed by entire success.

Let me mention, in the last place, the two following procedures: one consists in *excision* or *resection* of the tumor made up of the strictured portion; the other, devised by Bourguet (of Aix), and designated by the name of *collateral urethrotomy*, consists in replacing the constricted canal by a canal of new formation, without paying any attention to the stricture, which remains then at one side of the wound.

General Indications Relative to the Treatment of Strictures. Choice of Method.—Among the different methods of treating strictures, it is to *inflammatory atrophic dilatation* that the first rank should without contradiction be accorded. It is the most simple, the easiest to carry out, the most exempt from danger, that finally which gives the most durable results, especially if care be taken to continue the employment of it even when the patient appears to be cured. It is to it, then, that recourse should always be had by preference.

Unfortunately, this method is far from being applicable to all cases. Certain strictures are so painful and so contractile, that it is impossible to practise dilatation upon them. Certain others, after having admitted of dilatation up to a certain point, refuse, on pain of most serious accidents, to admit of further dilatation. Likewise, there are some in which the surgeon succeeds in passing very soon even quite a large bougie, but which close up again as soon as treatment is suspended; and, finally, there are others the consistency of which makes them absolutely undilatable. We have seen that *superficial cauterization* usually succeeds in diminishing the extreme sensitiveness of the mucous membrane, and so in rendering the passage of bougies possible.

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[1] Du cathétérisme rétrograde combiné avec l'uréthrotomie externe. (Archives Gén. de Méd., Juillet, 1883.)

In other cases it is necessary to give up dilatation, and to have recourse either to *divulsion* or to *internal urethrotomy*, or, finally, to *external urethrotomy upon a guide*.

The first two methods present almost analogous indications; nevertheless, *internal urethrotomy* seems to be especially suited to very tight fibrous strictures, and to those in which the mucous membrane presents folds and ridges which yield to the pressure exerted by bougies, only to reappear immediately afterwards, and the disappearance of which divulsion is unable to effect. It is customary to contrast internal urethrotomy and divulsion with one another, and to compare the advantages and disadvantages of these two operations. Without entering into a discussion which would lead me much too far, and while disposed to accord equal confidence to these two operations, I acknowledge that, from my own practice, I am inclined to prefer *divulsion*. In support of this entirely personal opinion, I will limit myself to citing the statistics of Lhirondel,[1] according to which divulsion is followed by less serious accidents and causes less frequently the death of those operated upon.

External urethrotomy upon a guide is indicated only in very complicated cases, in which there exists induration of the whole thickness of the perineal tissues, accompanied by multiple fistulæ constantly giving passage to urine. In the gravest cases there may be added to this *excision* of the stricture.

We have supposed up to this point that the stricture could be passed. When it is impassable, the conduct of the surgeon should vary, and it is necessary to distinguish the cases in which the patient can still urinate from those in which there exists retention of urine.

When the patient urinates, it is well not to be in too great haste. Often, by means of care and perseverance one succeeds, with the help of the different artifices which I have indicated, in getting through a stricture which one at first despaired of passing. When all the best-made attempts to pass a delicate bougie have remained fruitless, one may think either of *forced catheterization*, or of *external urethrotomy without a guide*, always giving the preference to the latter.

When there is complete retention of urine, the indication becomes urgent, and it is necessary either to *puncture* the bladder or to practise *urethrotomy without a guide*. Of these two operations the first is much the least grave, and the easiest to execute. I will add that it is very often possible, in the first days which follow puncture, to pass the stricture; which makes it possible to treat the latter by simple dilatation.

Suprapubic puncture should always be practised, either with a capillary trocar or with a large, curved trocar. In the first case, this puncture is repeated several times a day; in the second case the canula of the trocar is left in, and this mode of procedure has the advantage of permitting the performance of *retrograde catheterization* afterwards, in the way that I have described. In some cases, however, *external urethrotomy* imposes itself on one, so to speak; when, for example, a rupture of the urethra has taken place, followed by urinary infiltration and retraction of the two ends of the canal. [Another plan is to open the urethra behind the stricture by what is known as Cock's method,[2] a variety of the old *boutonnière;* the stricture can afterwards be dealt with in any way that may seem desirable.]

SPASM OF THE URETHRA; SPASMODIC STRICTURE OF THE URETHRA.—Spasm of the urethra consists in a transient, and almost always painful, contracture of the muscular fibres which enter into the constitution of the walls of this canal. The presence of these muscular fibres is at present well demonstrated, even in the spongy portion, but it is especially in the membranous and prostatic portions that the muscular apparatus of the urethra attains its greatest development, constituting at this point what is called the sphincter of the bladder.

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[1] Parallèle entre la divulsion et l'uréthrotomie interne. Thèse. Paris, 1872.

[2] See p. 413, *supra*.

Two varieties of spasm of the urethra may be admitted: one *idiopathic*, reflex in nature, and referable, as to cause, to disease of a neighboring organ; the other *symptomatic* of an irritation of the mucous membrane of the urethra.

(1) *Idiopathic Spasm and Contracture of the Urethra.*—The absence of precise anatomical notions relative to the arrangement of the sphincter of the bladder, causes the persistence of some doubts as to the exact seat of this disorder. Whilst certain authors consider the sphincter of the bladder, properly so called—that is to say the muscular ring which surrounds the urethro-vesical orifice—as independent of the muscular portion of the urethra, and as consequently susceptible of being separately affected with spasm and contracture, others, on the contrary, among whom I will cite Amussat, Dolbeau, Caudmont, and Guyon, admit as sphincter of the bladder not only the urethro-vesical orifice, but also the whole group of muscular fasciculi which enter into the structure of the prostatic and membranous portions of the urethra. Following these last authors, whose manner of looking at the subject I accept almost completely, contracture of the neck of the bladder cannot be distinguished from contracture of the urethra.

The reader should, therefore, be prepared to understand that when I speak of contracture and of spasm of the neck of the bladder, I refer to an exaggerated and permanent contraction, not only of the sphincter of the urethro-vesical orifice, but also of the muscles which enter into the composition of the prostatic and membranous portions of the urethra.

Etiology.—Authors have too much neglected, in my opinion, to establish a distinction between idiopathic spasm and symptomatic spasm of the neck of the bladder; whence results a deplorable confusion in describing the etiological conditions in which it is seen to arise.

Most of the diseases of the urinary passages determine, by reflex action, spasm or contracture of the neck of the bladder; in these conditions, the spasm or contracture represents only a symptom, important, it is true, of these diseases, and susceptible, in certain cases, of giving rise to special indications. But, in the absence of all material alteration of the organs which enter into the composition of the urinary apparatus, there may be observed an idiopathic contracture of the neck of the bladder, constituting a special disease, and it is principally this form of contracture which it is important to study.

While being idiopathic, in the sense that it does not depend on any affection of the urinary organs, contracture of the neck of the bladder is often seen as a consequence of the lesions of neighboring organs, or even of more remote ones; such is the contracture of the neck of the bladder which is observed in the course of diseases of the anus and rectum, of the uterus and vagina, or in consequence of some injuries and surgical operations. In such a case, the contracture is the expression of a phenomenon of reflex order, but generally does not persist longer than the cause which has given rise to it. As will be seen, even here we have not to do with true idiopathic contracture of the neck of the bladder. The same is true of contractures which are observed in the course of affections of the nervous centres—in meningitis, in the early stage of locomotor ataxia, or in hysteria or other grave neuroses. True idiopathic contracture of the neck of the bladder may be met with in both sexes, and it is more frequent than one would think in women. Although constituting chiefly a disease of the middle period of life, it may be observed at all ages, and even in infancy. It attacks especially individuals of a nervous temperament.

According to the opinion of Leroy d'Étiolles, and of Caudmont, contracture of the neck of the bladder is to be considered a frequent manifestation of the rheumatic diathesis, and the observation of a number of patients has enabled me to verify the exactitude of this assertion. The disease often appears to be developed under the influence of various causes, some of which act as predisposing, and others as determining causes; such are sedentary occupations, living in cold and wet places, the impression of cold, excesses of coitus, masturbation, excesses at table, etc.

Symptomatology.—Contracture of the neck of the bladder generally manifests itself by two sets of symptoms: troubles in micturition, and a variety of sensations, most frequently painful, felt by the patient. Nevertheless, it sometimes happens that the troubles of micturition exist alone, without being accompanied by true pains. Hence the necessity of distinguishing, as I have said already, a painless contracture and a painful contracture; the second variety being, however, much the most frequent.

I will begin, then, the description of the symptoms of contracture of the neck of the bladder with the troubles of micturition which exist alone in *painless* contracture.

The patients have frequent desires to urinate, which increase under the influence of cold and of dampness, and which manifest themselves especially during the night. In addition to being frequent, the inclinations to urinate are so imperious that the patients are obliged to satisfy them immediately, and that, if they are prevented by any cause whatever from doing so, the urine escapes involuntarily.

Important modifications are manifested in the form, the size, and the force of the stream of urine—modifications analogous to those which are seen in strictures of the urethra; but what gives this symptom a peculiar character in contracture of the neck, is principally, and especially at the outset, its irregularity and its intermittence. Whilst the modifications of the stream of urine are constant in stricture of the urethra, in contracture, on the contrary, the stream of urine is sometimes large, rapid, and expelled with force, sometimes small, filiform, twisted, interrupted, and without projectile force to such a degree that the patients "wet their boots," according to the common expression; besides, they are compelled to make reiterated efforts, and to wait a longer or shorter time, either to start the first flow of urine, or to expel the last drops. Finally, in consequence of the obstruction to the flow of urine, and also in consequence of the gradual weakening of the contractile power of the bladder, micturition is often very prolonged. In order to omit nothing from the enumeration of the functional troubles which characterize contracture of the neck of the bladder, I ought to mention a symptom which it is not rare to see accompany various troubles of micturition; I wish to speak of erections, which by their persistence, especially during the night, become a source of fatigue. In one of my patients, affected with contracture of the neck of the bladder, this symptom became extremely painful.

To these various functional troubles come to be united very often, as I have said, more or less marked *painful* phenomena, which characterize the second variety of contracture of the neck of the bladder. The pain felt by the patients manifests itself at the beginning and during the whole continuance of the micturition. It is more or less acute, according to circumstances, that is to say, it presents intermissions; in general, cold, fatigue, and excesses of all kinds exasperate it. Sometimes localized in the glans, behind the pubis, or in the perineum, it radiates often through the whole length of the penis, to the groins, the thighs, and the anus. In many patients it is accompanied by a chill. As to the characteristics of this pain, they vary like its intensity. Patients generally compare it to a burning sensation, which some characterize by saying that it seems to them as if a red-hot iron were passed through the canal. It is rare that idiopathic contracture of the neck of the bladder persists for a long time without determining at length various complications. In certain cases, even at the beginning, the difficulty of micturition may reach a point at which there supervenes a true retention of urine, necessitating the employment of a catheter. In many patients there is an incomplete retention, the bladder does not empty itself completely, and they have overflow-urination.

It is especially in these conditions that there are seen to arise, as complications, catarrh of the bladder, and even nephritis; the urine becomes turbid, mucous, purulent. On the other hand, the painful contracture is communicated to the adjacent organs—to the sphincter of the anus, to the muscles of the perineum, to the vulva—constituting what Velpeau called *ano-vesical neuralgia*, and Roux, *ano-genito-urinary neuralgia.* Finally, according to Mercier, persistent contracture of the neck of the bladder may ultimately cause a peculiar deformity of this orifice, consisting in the production of a muscular valvule, situated most frequently behind but sometimes in front, and resulting from the hypertrophy and retraction of the transverse muscular fibres which form the internal sphincter of the neck of the bladder. As these transverse fibres are much stronger at the posterior part, where they blend, and are continuous with those of the trigonum, it is explicable that the posterior valvule is much more common and more marked than the anterior. In some cases two valvules are observed, one in front and the other behind; but the latter is always the more conspicuous. The presence of these valvules introduces a new obstacle to the emission of urine; it creates, further, a difficulty in the introduction of the catheter, inasmuch as there is formed in front of these valvules a more or less deep *cul-de-sac*, in which the end of the instrument is caught.

Diagnosis.—From the stand-point of diagnosis, it is important to remember that, since contracture of the neck of the bladder is very often symptomatic, we should expect to meet with it in many affections of the urinary passages; but in these maladies, it is most frequently easy enough to distinguish what belongs to the original affection from what belongs to the contracture. It is chiefly when it is a question of recognizing idiopathic contracture, that the diagnosis presents serious difficulty. Formerly this affection was very often confounded with calculus of the bladder, but this mistake appears to me to be hardly possible any longer, with our methods of exploration. The same is not true of another mistake, which consists in taking contracture of the neck of the bladder for organic stricture of the urethra; this confusion is, even at the present day, still very often committed. However, it may be avoided by having recourse to methodical exploration of the urethra, and by analyzing the results furnished by this exploration and by those which yet remain to be described.

The functional symptoms are, indeed, insufficient to establish the diagnosis of contracture of the neck of the bladder, and in the presence of a patient presenting the symptoms just indicated, the surgeon ought to proceed to sounding with an exploratory *bougie-à-boule* (No. 16 of the scale of Charrière). The instrument, arrived at the entrance of the muscular portion of the urethra, is suddenly arrested; but if it be held here with a gentle pressure, it is not long before it slowly penetrates this portion, giving the surgeon the sensation of a peculiar resistance, as if the exploratory bulb were firmly grasped; at the same time the patient complains of a cutting, or even a burning, pain, sometimes severe enough to cause syncope—a pain which lasts all the time that the instrument takes in passing through the muscular portion. The sensation of resistance which the surgeon perceives, as well as the pain felt by the patient, diminishes as soon as the sound has passed the muscular portion and while it is going through the prostatic portion; afterwards the same phenomena are reproduced, but more briefly and less markedly perhaps, at the moment when the bulb passes the urethro-vesical orifice and actually enters the bladder. When the surgeon withdraws the instrument, he perceives the same resistances, but with less distinctness, while at the same time the pains of the patient are less intense.

If matters always took this shape, the diagnosis of contracture would be extremely easy, and there would be no difficulty in distinguishing it from true organic strictures which never admit of being passed by a bulb No. 16. But not infrequently exploration with a *bougie-à-boule* furnishes different results. When it has reached the neighborhood of the muscular portion, the instrument is found to be absolutely stopped, and, even on beginning again with a much smaller bulb, the same result is always obtained. This may be due to two causes; sometimes the extremity of the instrument is caught in the *cul-de-sac* of the bulb of the urethra—the depth of which is increased by the contracture of the muscle of Wilson—or in the *cul-de-sac*, which I have mentioned, in front of a valvule of the neck of the bladder; sometimes the contracture is so firm and permanent that it does not give way, and does not permit the passage of even a very delicate instrument, behaving absolutely like a true organic stricture.

In the first case, if the instrument is arrested in the *cul-de-sac* of the bulb, or in a valvular *cul-de-sac*, one sometimes succeeds in avoiding the obstruction by following the upper wall of the urethra, by pulling strongly upon the penis and carrying it up towards the abdomen, and, finally, by introducing into the catheter a small stylet to which a slight curve is given. In the second case, that is to say, when the contracture is such that it will not admit of the passage of an exploratory bougie, one may often succeed, it is true, in passing the obstruction with an ordinary bougie, more or less delicate, but this instrument does not furnish any peculiar sensation, and in such a case it would be impossible to decide whether there were present a contracture of the neck of the bladder, or an organic stricture of the urethra. Under these circumstances, I have believed that I could find a diagnostic sign, which, if not infallible, was at least very valuable, by determining the position of the obstruction by measurement. Every time, indeed, that the obstruction is situated about fifteen centimetres from the meatus, it may be affirmed almost certainly that the obstruction is due to a contracture and not to an organic stricture, which, ordinarily, is situated at most at a distance of twelve, thirteen, or fourteen centimetres.

Prognosis.—Contracture of the neck of the bladder is always a serious disorder, not because it often compromises the life of the subject affected with it, but because it always shows great tenacity, and even sometimes constitutes an almost incurable malady. Symptomatic contracture is a troublesome complication of a great number of affections of the urinary passages, and, although disappearing ordinarily with the cause which gives rise to it, it sometimes requires the employment of special measures.

It is principally to idiopathic contracture that what I shall say as to the gravity of the prognosis is applicable. Its duration is always very long; it ends by altering the general health and especially the *morale* of certain patients, who become hypochondriac, and sometimes even put an end to their sufferings by suicide. Finally, the persistence of the disorder, and its resistance to different methods of treatment, have led surgeons to propose for it grave operations, which, while sometimes furnishing complete cures, nevertheless expose the patient to serious and even fatal accidents.

Treatment.—As symptomatic contracture generally recovers with the disease of which it is a symptom, it is against the latter that treatment should at first be directed, but if the contracture outlasts the cause which has given rise to it, or if there be an idiopathic contracture, recourse must be had to special treatment, both *general* and *local.*

The *general treatment* varies according to the patient's state of health, and according to the predominance of certain symptoms. For enfeebled, anæmic subjects, the preparations of iron and cinchona are indicated. For the nervous, and when painful symptoms are well marked, antispasmodics should be prescribed, and anodynes: the bromide of potassium, the bromide of camphor, the oxide of zinc, the valerianate of ammonium, of quinine, etc. For the rheumatic, the iodide of potassium, colchicum, and the alkalies may be useful. But, whatever may be the probable cause of the contracture, it may be said, in a general way, that, in the absence of special contra-indications, hydrotherapy is one of the modes of treatment which gives the best results. With a number of patients in whom all the resources of general and local therapeusis had failed, this method has secured for me, if not complete cure, at least considerable amelioration.

The *local treatment* of contracture is of great importance, and often furnishes good results. It comprises the employment of a number of methods. One of the most simple consists in the introduction of larger and larger sounds, which act on the one hand by diminishing the sensitiveness of the canal, and on the other hand by producing progressive distension of its muscular tunic. In fine, it is a method absolutely similar to the method of slow and progressive dilatation which is employed for organic strictures of the urethra, and which I have already described. Flexible bougies may be employed, introducing them every day, increasing the calibre of the instrument, and leaving it in place for several minutes. Again, use may be made of the series of pewter sounds, known by the name of "*sondes Béniqué.*" In certain cases, in which there has been great difficulty, renewed at each sitting, in introducing a bougie, I have left the instrument in place, absolutely as if there had been present an organic stricture of the urethra, and this practice has served me well. If progressive dilatation prove insufficient, recourse may be had to cauterization of the neck of the bladder, according to the method devised by my colleague Guyon, and which consists in instilling a few drops of a solution of nitrate of silver (1 to 50, 1 to 30, 1 to 20) by means of a hollow *bougie-à-boule* and a Pravaz syringe. Without dwelling upon the details of this little operation, which is described in all special works on urethral affections, I will merely say that the hollow bougie being introduced until the bulb has penetrated to the muscular portion of the urethra, the surgeon, with one hand, fixes it in this situation, while with the other hand he insinuates the canula which terminates the syringe of Pravaz, and gently forces in the fluid. The quantity ought not to exceed fifteen or twenty drops. This little operation should be repeated every two or three days. In spite of the successes obtained by this method of treatment, it is far from being always efficacious, and the surgeon may then be obliged to come to graver operations, like sudden and forced dilatation, or cystotomy.

Forcible dilatation of the neck of the bladder, tried by Récamier, Civiale, and Nélaton, has been recommended by Tillaux, who has designed two dilating instruments, one for men and the other for women. I have had recourse to this operation; and in two cases, in which other measures had failed, I thus obtained an almost complete cure. I used in both cases the divulsor of Voillemier, of which I have spoken in connection with the treatment of organic strictures of the urethra. Finally, in cases which have proved rebellious to all treatment, recourse has been had to *cystotomy*, which has been followed by success at the hands of Dolbeau and of Verneuil in France, of Paroni in Italy, of Lawson Tait in England, and of Marion Sims in America. The adoption of this procedure in desperate cases of chronic cystitis of the neck of the bladder, which are constantly complicated with contracture, has been elsewhere referred to.[1]

(2) *Symptomatic Spasm and Contracture of the Urethra.*—This second variety of spasm or contracture of the urethra is much more frequent, and may occupy any part of the canal, although it most often affects the membranous portion. It is thus that irritation of the mucous membrane by the presence of a foreign body, or by the introduction of a catheter or any other instrument, immediately determines a spasm of the membranous portion, which often prevents the foreign body or the catheter from penetrating to the bladder. This spasm generally gives way at the end of a few minutes.

Likewise the irritation of the mucous membrane produced by acute urethritis, or by the presence of a stricture in the spongy portion, provokes, in the deep portions of the urethra, a more or less pronounced spasm. It is on the existence of this same symptomatic spasm that Verneuil[2] in France, and Otis[3] in America, have attempted to found a doctrine in opposition to the ideas generally received as to the habitual situation of organic strictures of the urethra.

According to these authors, organic strictures of the urethra have their most frequent seat in the spongy portion, and the arrest which is experienced at the level of the neck of the bulb is due to contracture of the membranous part, provoked by irritation of the mucous membrane at the point of stricture from the passage of the bougie. These authors even go so far as to claim that simple irritation of the meatus, in consequence of the introduction of a bougie, suffices to provoke spasm of the membranous portion, and to simulate an organic stricture situated at the neck of the bulb. While admitting to a certain extent the spasmodic contraction of the membranous portion of the urethra, in the conditions mentioned, I cannot attribute to it the importance accorded to it by Verneuil and Otis, and can still less accept the conclusions which they have drawn from it, relative to the habitual seat of organic strictures. It remains well demonstrated by extremely numerous facts, as I have elsewhere established, that organic strictures of the urethra are most frequently situated at the level of the neck of the bulb.

Independently of spasm of the muscular portions of the urethra caused by a stricture, can this provoke a spasm at its own level; or, in other words, can a stricture be contractile? The fact is indisputable, from the results of clinical examination, and one may see every day a stricture, which had been passed just the minute before, opposing an invincible obstruction to the same instrument. Further, the existence of spasm of a stricture is perfectly consistent with our anatomical knowledge. It is evident that in very deep cicatricial strictures, in which the whole thickness of the wall is replaced by fibrous tissue of new formation, all contractility, all spasm, is impossible; but if there be a moderate stricture, or even a very thick, dense stricture, limited to one part of the circumference of the canal, as there exists still at its level a certain number of muscular fibres, either in the whole circumference or only in one part, it is conceivable that spasm may be produced at this point with an intensity all the greater as the muscular fibres which have been preserved are more numerous.

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[1] See p. 349, *supra*.

[2] Folet, Des rétrécissements péniens de l'urèthre (Archives Gén. de Méd., tome i. p. 401, 1867); Landeta, Thèse. Paris, 1867.

[3] Hospital Gazette, April, 1879.

Treatment.—The treatment of idiopathic spasm of the urethra has been studied in connection with the subject of contracture of the neck of the bladder, and I shall not return to it. In regard to symptomatic spasm, the surgeon should direct his treatment against the cause which has given rise to it. For very acute inflammation of the urethra, he will prescribe an energetic antiphlogistic treatment; in case of exaggerated sensitiveness of the mucous membrane (irritable stricture), narcotics, antispasmodics, and direct cauterization of the mucous membrane should be employed, and afterwards methodical treatment of the stricture itself. If these means fail, recourse may be had to anæsthesia, and urethrotomy or divulsion may be practised.

URINARY POUCHES.—Urinary pouches are cavities which communicate with the urethra, and in which urine remains in the intervals of micturition. I shall describe two varieties: in the first the canal is simply dilated, and its walls have not undergone any solution of continuity; in the second the urethra is perforated, and the urine is contained in a sort of sac, formed at the expense of the peri-urethral tissues and communicating with the canal.

(1) *Urinary Pouches from Dilatation of the Urethra.*—These pouches may be *congenital*, but they are almost always *accidental*, a condition indispensable to their production being the existence in the urethra of an obstacle to micturition (stricture, foreign body). The mechanism of their formation is, moreover, easy to conceive. The bladder, hypertrophied in consequence of the contractions to which it is compelled in order to void its contents, exerts on the walls of the urethra situated above the obstruction a more and more energetic pressure, which separates them violently and ends by causing dilatation.

Pathological Anatomy.—The anatomical characteristics of these pouches differ notably according to the causes which give rise to them. Those which are due to the presence of a *calculus* are generally situated in the perineum, at the root of the scrotum. Sometimes, however, they are found in front of the scrotum and even very near the glans. In the perineum they are ovoid or globular, and of quite large dimensions; their form is more elongated, and their size is much smaller, in the spongy region, where they constitute a simple dilatation of the urethra, the length of which may equal or surpass five centimetres. Their development is very rapid, but often intermittent, when the stone is movable and falls back into the dilated portion of the canal under the influences of certain positions of the patient. When, on the contrary, the stone is not movable, the enlargement of the pouch becomes continuous, and its capacity often considerable. The mucous membrane of the dilated portion preserves its normal appearance as long as the pouch has not attained too great a size, and it presents alterations only at the level of the point occupied by the calculus. Urinary pouches which follow a *stricture* are almost always situated in the perineal portion of the urethra. They develop slowly, and their size is in general not very great. Their shape is sometimes rounded, more often elongated, and the mucous membrane which lines their cavity is almost always inflamed, softened, and even destroyed. Their walls are pale and of hard consistence, with a fasciculated appearance dependent on the presence of longitudinal, elevated ridges, separated by little cavities, of which some are simple *culs-de-sac* and others dilated glandular orifices. At an advanced period the elements which enter into the composition of the membranous and prostatic portions become so profoundly altered that they are almost unrecognizable.

The differences which I have just mentioned depend on the condition of the urethra, the walls of which have preserved, in the first case, their suppleness and their normal dilatability, whilst in the other case they have become hard, friable, and inextensible.

Symptomatology.—Urinary pouches present themselves in the shape of ovoid or elongated tumors, seated upon the urethra, without change of coloration of the skin, soft, painless, capable of being completely emptied and of passing unperceived, but reappearing at the moment of micturition to become then hard, tense, resistant, and fluctuating. The patient, who soon recognizes the nature of his lesion, attempts to empty the pouch by holding his penis in the left hand, whilst with the right he exercises pressure on the tumor, directed from behind forwards. But the pouch is never completely emptied; there remains in it a small quantity of urine, which afterwards flows out, soiling the clothing. A phenomenon of the same order is produced in coitus. The spermatic fluid, instead of being projected outside, falls into the pouch, and escapes only with difficulty at the end of a longer or shorter time.

The *treatment* of these cases ought to be directed exclusively to the obstruction which is opposed to the emission of urine. If there be a calculus, extraction, carried out by any of the methods which I have mentioned, will generally be followed by a rapid and complete contraction of the urinary pouch. It is different in the case of a stricture. After the cure of the latter, the contraction of the pouch takes place only with extreme slowness, because of the density and induration of its walls.

(2) *Urinary Pouches from Perforation of the Urethra.*—Urinary pouches belonging to this second variety are not limited by the wall of the urethra, but rather by the indurated and thickened peri-urethral cellular tissue. They follow collections of blood or pus, at first situated outside of the canal, and then communicating with it by openings of variable dimensions, through which urine escapes, fills the spaces, and transforms them into urinary pouches.

The *symptomatology* of these tumors differs very little from that of the preceding variety; there are the same shape, the same painlessness, the same situation in the median line, the same adherence to the urethra, and the same facility of being incompletely emptied and of filling up at the moment of micturition. They are, however, distinguished by the following peculiarity: whilst urinary pouches from dilatation of the urethra contain at every period of their development absolutely normal urine, this is always mixed with a certain quantity of pus in cases in which the urinary pouch has followed an abscess or a blood-tumor.

Treatment.—When the pouch is small, it suffices to keep in the urethra a catheter of moderate calibre, and at the same time to exercise light compression on the perineum. When, on the contrary, the pouch is large, the prolonged presence of urine almost inevitably brings about the formation of an abscess which opens of itself at the surface of the skin, but which it is much better to incise promptly, introducing a catheter to prevent the establishment of a fistula.

URINARY ABSCESSES.—Urinary abscesses are purulent collections resulting from the passage of urine through narrow perforations of the urethra. The urine penetrating but slowly into the meshes of the peri-urethral cellular tissue, sets up around the points which it occupies an adhesive inflammation, which limits the infiltration; but soon playing the part of a very irritating foreign body, it provokes suppuration, and often even gangrene of the tissues with which it is in direct contact. Thus are formed the purulent collections which we are about to study, and of which it is well to admit two varieties, one *acute*, the other *chronic*.

(1) *Acute Urinary Abscesses.*—These abscesses, which are always caused by the existence of a more or less tight stricture, present symptoms and run a course varying with the seat of rupture. When the latter is produced at the level of the membranous portion of the urethra, behind the triangular ligament, the abscess is developed in the prostatic fossa. The patient then complains of pain, of frequent calls to urinate, of a feeling of weight about the perineum and rectum, of malaise, and of light chills. But the collection, held in and bound down by the triangular ligament, can make only an altogether inappreciable swelling in the anterior part of the perineum; it makes its way into the ischio-rectal fossæ, and shows itself externally by brawniness, and afterwards by gangrenous patches very near the anus. This is, however, a rare form of urinary abscess; most frequently, on account of the customary situation of strictures, lacerations of the urethra are produced in front of the triangular ligament. Then the abscess is developed in the anterior perineal region, determining certain not very well-marked manifestations, such as slight chills, short febrile movements, tension in the perineum, and increased difficulty in micturition. At the same time the anterior perineal region becomes the seat of a rounded, hard, painless tumor, developed in the direction of the urethra, extending at the same time to the side of the anus and of the scrotum, and most frequently continued upon the penis, which appears as if buried in it, and soon becomes resistant and painful to the touch.

Very rarely the collection opens into the urethra; then there flows in the intervals of micturition a yellowish and thick pus, which escapes with greater abundance if the tumor be gently squeezed. The latter diminishes gradually, and ends by disappearing, leaving behind a small indurated nodule which is at length absorbed. Usually the opening of the abscess takes place externally, occasioning, however little it may be delayed, grave disorders resulting from infiltration of urine and pus into the surrounding cellular tissue.

In the *diagnosis* of urinary abscess, simple enough in general, there may nevertheless arise a double error. The first mistake, which it is almost impossible to avoid before opening the collection, consists in taking an abscess of the perineum, not communicating with the urethra, for a urinary abscess. The opposite error is more frequent; a patient presents behind the scrotum a deeply situated fluctuating tumor, which is opened, and the contents of which are purely purulent; it is believed to be a simple abscess, but at the end of a few days urine flows through the wound.

The *treatment* consists in free incision of the tumor, practised even before fluctuation has become evident. To avoid all error, it should be remembered that, the abscess being almost always situated at a great depth, the parts should be divided through a thickness which may reach four, five, and even six centimetres. As soon as the swelling has disappeared, and the wound is on the road to repair, no time should be lost in treating the stricture itself, and in introducing a catheter, which should be left in position in order to prevent the establishment of a fistula.

(2) *Chronic Urinary Abscesses.*—These abscesses are much less frequent than the preceding, which is well enough explained by the eminently irritating action exercised by the urine which is infiltrated into the tissues. Of these abscesses, some occupy the perineum, others the pendulous portion of the penis. Those which are situated in the perineum present themselves in the form of small tumors, rounded or slightly elongated, hard, adherent to the urethra, covered by normal skin, and so painless that they usually escape the attention of the patient. These abscesses are susceptible to resolution, either spontaneous, or in consequence of rational treatment. Almost constantly they are seen to pass into the acute state under the

influence of traumatism, of fatigue, of errors of regimen, or, again, of too rapid dilatation of a stricture. The treatment consists in the application to the perineum of emollient cataplasms and of resolvent pomades, and in the employment, as prudently as possible, of bougies and catheters.

Abscesses of the pendulous portion of the penis are sometimes multiple, and form little nodules which are hard, painless, adherent to the canal, and covered by perfectly healthy and movable skin. They may remain a long time stationary, and sometimes even terminate by resolution. Much oftener, they are seen to inflame, soften, and finally open on the cutaneous surface. One might believe, in such a case, that the collection was a simple peri-urethral abscess, were it not for the persistence of the cutaneous opening and for the presence of urine in the liquid which escapes from it.

Tumors and Neoplasms of the Urethra.—*Cancer.*—Primitive cancer of the urethra (*epithelioma*) is extremely rare, and almost always the organ is invaded secondarily. This will be referred to in another article, in connection with cancer of the penis.

Vegetations or Polypi.—I have already, when speaking of the pathological anatomy of stricture, said something about the *carnosities* or *caruncles* which are described by ancient authors, and which, though rare, may be met with in the urethra in the shape of little vegetations situated behind the stricture. Are these true polypi of the urethra? Thompson, indeed, reports the observation of a urethra, presenting at the junction of the prostatic and membranous portions a pedunculated tumor, nine lines long and three or four broad; but Voillemier expresses some doubts as to the true nature of this production, which appear all the more well founded, since Pro, who described the same specimen, considered the supposed polypus a simple fold of the mucous membrane. There are sometimes met in the fossa navicularis pathological products which present a structure absolutely analogous to that of the vegetations seen on the surface of the prepuce and of the glans. They are slowly developed in the interior of the canal, where they preserve a rather elongated shape, but spread as soon as they have passed outside of the meatus.

Their *treatment* is simple. It consists in tearing or cutting off the little tumors.

Vices of Conformation of the Urethra.

The vices of conformation of the urethra present numerous varieties which may be all referred to a small number of well-defined types, which we shall examine in the following order; *congenital strictures*, *occlusions of the meatus and of the urethra*, *urinary pouches*, *hypospadia* and *epispadia.*

Congenital Strictures.—Congenital narrowing of the meatus is often observed. It is sometimes so pronounced that it hardly permits the introduction of a very delicate stylet, and causes great hindrance to micturition. It frequently accompanies phimosis. The existence of congenital strictures situated at other points of the urethra does not appear to have been perfectly demonstrated. An observation of Phillips and another of Syme, reproduced by some authors as cases of congenital stricture, refer to patients affected with dysuria from their infancy, and in whom nothing authorizes us to admit the existence of such a stricture. The few records of pathological anatomy concerning individuals in whom have been discovered membranous folds of the mucous membrane, sorts of valvules simulating strictures, are themselves of only moderate assistance toward the elucidation of this question.

The best means of remedying congenital atresia of the meatus consists in enlargement of the orifice, practised by means of a cutting instrument, and followed by the introduction for several days, and to a slight depth, of a large bougie, in order to force the lips of the wound to cicatrize separately. [Another plan, known as Weber's, consists in dissecting a strip of skin from around the orifice, and then splitting and everting the mucous membrane, which is finally attached to the skin by several points of suture.]

Occlusions of the Urethra.—These occlusions, which result from gluing together of the two corresponding halves of the penis, may occupy any point in the canal, but the meatus urinarius is their seat of election. Sometimes the mucous membrane of the glans is seen to pass in front of the meatus, without anything being seen at this point which could indicate the existence of an orifice. In a case of this sort, observed by Voillemier, the mucous membrane was so delicate that it protruded at every effort of the child to urinate, and seemed ready to burst. Most frequently the meatus is well formed, and ends in a *cul-de-sac* at a distance of a few millimetres. We have only a very small number of examples of occlusion situated at other points of the canal; I will cite a very interesting case of this sort reported by Gourdon,[1] in which there existed a double occlusion, one at the level of the meatus, the other in the neighborhood of the neck.

The *diagnosis* is especially easy when the occlusion is in the meatus or in the fossa navicularis. Deeper occlusions may escape the first examination, but the ineffectual efforts of the infant to urinate, and sounding with a curved stylet or a very small catheter, will usually render error impossible.

The *treatment* consists, for occlusions of the meatus, in simple puncture practised with a bistoury or a lancet. For deep occlusions, forced catheterization has usually furnished excellent results, this depending upon the fact that in general the occlusion is only of slight extent.

Complete obliterations of the urethra are the result of fusion of its walls, and of their transformation into a fibrous cord. This vice of conformation, happily quite rare, is usually complicated with other anomalies which are beyond the resources of art, such as imperforate rectum, or communication of that organ with the bladder.

Congenital Urinary Pouches.—This vice of conformation, described likewise under the name of *congenital dilatation of the urethra*, is of extreme rarity. Guyon, in his thesis,[2] reports only two observations of it, one by Dr. Angers, and the other by Hendriksz, of Amsterdam.

The first case (Fig. 1337) was that of a child of three years, poorly developed, which had beneath the penis a cutaneous appendage, thick, irregular, four and a half centimetres in circumference, and formed by a pouch which, in the empty state, was flattened laterally and had a number of vertical folds. The penis, of normal size, presented in the direction of its length a very marked concavity of its dorsal aspect. The meatus urinarius was well formed. A stylet introduced into the urethra, following the upper wall of this canal, passed easily into the bladder, whilst with the same instrument curved and following the lower wall, quite a large cavity corresponding to the pouch was penetrated. At the moment of micturition, this pouch swelled up little by little and acquired the dimensions of a hen's egg. Its walls were then smooth and transparent. The urine, on leaving the bladder, first filled the pouch and then escaped normally by the meatus. When micturition was ended, the pouch remained full, and was emptied only by pressure.

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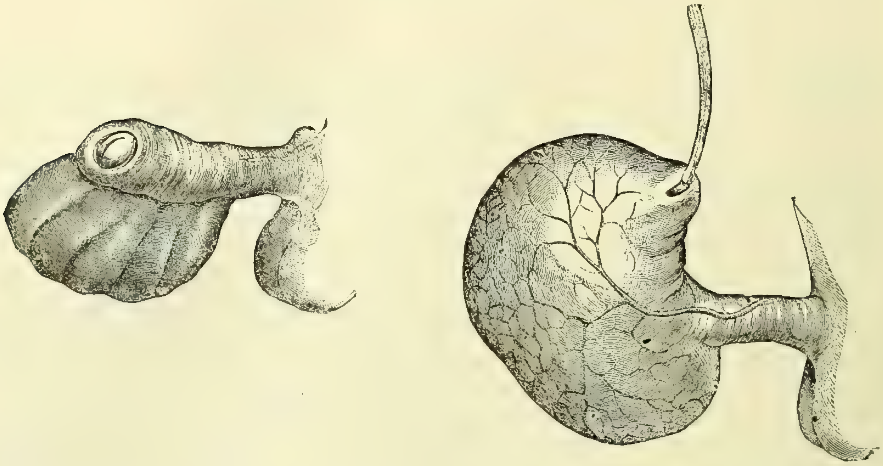
[1] Journal des Connaissances Médicales, 1834.

[2] Des Vices de Conformation de l'Urèthre, Thèse d'Agrégation, 1863.

In the second case, seen in a child of eight years, the penis presented an almost analogous conformation. The tumor, more voluminous than in the preceding case, was prolonged from the fossa navicularis to the arch of the pubis; its capacity was great enough to contain all the urine of one micturition, and the child emptied it by compressing it strongly with both hands. Exploration with a stylet made it possible to ascertain the normal state of the upper wall and the absence of the lower wall, from the fossa navicularis to the arch of the pubis. The following is the manner in which Hendriksz proceeded to remedy this deformity. The tumor was included between two semi-elliptical incisions, the skin being first divided, and then the proper membrane of the pouch, constituted by the distended and thinned mucous membrane of the urethra. It was then ascertained that this mucous membrane formed near the anterior and posterior extremities of the sac, two valvular folds, which the surgeon incised and destroyed. This done, and a sufficient portion of the walls having been cut away, the lips of the mucous membrane and those of the cutaneous wound were united separately, the first by means of points of interrupted suture, the other by means of the glover's suture; and a catheter was left in.

Fig. 1337.



Congenital urinary pouch, flaccid, and distended with urine at the moment of micturition. (After Angers.)

In both these cases there was not a dilatation of the urethra, but a vice of conformation closely allied to hypospadia, having the same pathogenesis, and only differing from it in the conservation of the mucous membrane and the skin.

The following deformities are likewise worthy of being mentioned:—

(1) *Abnormal Opening of the Meatus.*—The meatus may open on the dorsal aspect, or at the side of the glans. A number of varieties of this sort have been observed by Malgaigne, and Guillon presented, in 1843, to the Academy of Sciences, a subject in whom the meatus urinarius opened at the extremity of a sort of pouch, with quite thin walls, placed at the right side of the glans. The stream of urine described almost a right angle with the penis, and divided like the water which escapes from the nozzle of a watering-pot. To correct such a vice of conformation it suffices to create a new meatus at the end of the glans.

(2) *Abnormal Opening of the Ureters into the Urethra.*—This malformation is always accompanied by a more or less complete absence of the bladder.

(3) *Opening of the Rectum into the Urethra.*—This vice of conformation, which is always complicated by an obliteration of the anus, will be studied with *malformations of the anus and of the rectum.*

(4) *Duplication of the Urethra.*—True duplication of the urethra, that is to say, division by bifurcation or partitioning of a single and median organ, does not appear to have ever been observed. The glans may, however, have several openings, some opening into the urethra, others terminating in a *cul-de-sac.* In a case reported by Cruveilhier there was on the dorsal face of the penis a secondary canal, which this author considered to represent the ejaculatory ducts. Finally, there have been observed cases of double penis, joined side by side or superimposed, in which the presence of two urethras was recognized in the same individual.

HYPOSPADIA.—Hypospadia is a vice of conformation characterized by fission or absence of the lower wall of the urethra, in such a manner that the canal opens on the lower surface of the penis at a variable distance from the extremity of the glans. This vice of conformation was known to the ancients. Aristotle mentions it; Galen, who describes it clearly, first made use of the expression "hypospadia," and Dionis believed it to be due to an imperforate state of the glans, followed by rupture of the urethra. Considered until the end of the last century as a pathological curiosity, but better described as to its nature and its varieties by the authors of the commencement of this century, hypospadia has been the subject of a certain number of separate therapeutic essays by some surgeons, such as Dupuytren, Dieffenbach, and Bégin. But its surgical history hardly dates back of the memoir of Professor Bouisson, which appeared in 1861. My own researches upon this subject were first published in 1874, and were completed in 1880.

Etiology, Pathogenesis.—Hypospadia is quite a common vice of conformation, which is met with once in three hundred individuals (Bouisson). The causes of it are very obscure. There are, however, quite a large number of facts which prove in an incontestable manner the heredity of hypospadia, and the existence of an original influence which appears to predispose all the members of a family to this vice of conformation. Hypospadia is the result of an arrest of development. As the works of Coste have established, the prostatic and membranous portions of the urethra are developed at the expense of the internal genital organs, in consequence of a gradual coarctation of the vesical cavity, which separates the openings of the spermatic ducts from those of the ureters. The balanic and penile portions are formed at the expense of the external genital organs. The *superior external genital buds* of Coste, situated at each side of the uro-genital sinus or external cloaca, give rise to the corpora cavernosa. These two eminences approach the one toward the other, above the upper angle of the sinus, and unite by their upper or dorsal aspect, leaving between the opposite surfaces a groove or channel with its concavity below. At this epoch there is no distinct sex. The uro-genital sinus, broad posteriorly, is separated from the anus by a transverse partition, while in front it is continuous with the inferior groove of the corpora cavernosa. At the same time there appear below the future corpora cavernosa two protuberant spheroidal bodies (*inferior external genital buds*), presenting at first no difference, no matter what may be the sex of the embryo in which they are observed, and destined to give origin to the scrotum or labia majora. The inferior buds increase the depth of the uro-genital sinus at its middle part. Further back opens the urethra, reduced to its membranous and prostatic portions, whence the vulvar appearance presented by the external genital organs at this epoch of their development. If at this period any cause arrests the work of organization, which has reached the point of the closure of the scrotal pouch, *perineal* or *perineo-scrotal* hypospadia is established. If on the contrary, the work of organization continuing, the arrest of development does not take place until after the inferior buds have united in the median line, it is in the re-entrant peno-scrotal angle that the orifice of the urethra opens, and *peno-scrotal* hypospadia results. The penile portion of the urethra results from the fusion in the median line of the two lateral edges of the groove constituted by the development of the superior external genital buds. The absence of the union gives rise to *penile* or *balanic* hypospadia.

Perineo-scrotal hypospadia is usually complicated by an absence of the anterior part of the urethra. Sometimes, however, even when posterior evolution is arrested, anterior evolution may be effected. Then the anterior canal exists, although fusion of the posterior portion of the urethra may not have taken place. Sometimes, finally, fusion of the urethra anteriorly, instead of being wanting for a considerable extent, is only wanting at one point in the continuity of the urethra, whence arises the formation of a sort of *congenital fistula*. Hence two chief forms of hypospadia: (1) that in which the urethra is absent in front of the opening, and which is much the more common; (2) that very rare form in which the urethra exists in front of the abnormal opening.

Pathological Anatomy.—I shall admit, with the majority of authors, three kinds of hypospadia, which I shall describe successively under the names of *balanic or glandular*, *penile, and scrotal;* this last kind comprises two varieties, for which I have proposed the denominations of *peno-scrotal* and *perineo-scrotal hypospadia.*

(1) *Balanic or Glandular Hypospadia.*—This is the form in which the opening of the urethra is situated on the lower surface of the glans. There is no frænum. The canal, arrested at the base of the glans, is continued to the extremity of the latter by a shallow groove, constituted by the upper wall of the fossa navicularis. The opening, often masked by the skin of the penis, which forms at this point a sort of valve, is rounded or transverse, and sometimes so minute that it can only with difficulty be traversed by the most delicate probe. In certain cases, in front of the hypospadic opening, there is a second opening, situated at the extremity of the glans and terminating in a *cul-de-sac.* These two openings communicated in a case reported by Jarjavay.

The shape of the glans is modified in balanic hypospadia. This organ is flattened, spread out, and recurved at its point. The thick prepuce, as if gathered back, covers only the dorsal surface of the glans, in the manner of the prepuce of the clitoris; sometimes, even, it is altogether wanting. Ordinarily there is a slight curvature of the penis at its anterior part. In a certain number of cases there have been observed, as very rare complications of balanic hypospadia, the following malformations:—

Torsion of the penis existed to a high degree in a case reported by Professor Verneuil. The dorsal surface of the penis looked towards the scrotum, and its urethral surface was turned forward and to the left. The urethra had undergone a corresponding deviation; it was carried from right to left, and from before backwards, twisted in a spiral round the lateral surface of the left corpus cavernosum, and resumed its median position only at the level of the root of the scrotum. An almost analogous arrangement existed in a patient seen by Guerlain. These deviations are often accompanied by *cryptorchidism*, or by *absence of one corpus cavernosum.*

Balanic hypospadia may also exist with the malformation known under the name of *webbed penis*, which consists in a true webbing by a cutaneous fold, interposed between the lower surface of the penis and the anterior part of the scrotum. This fold, triangular in shape, holds the penis bound back, and offers a very marked hindrance to erection.

Finally, preputial hypospadia may be likewise complicated by a *bifid condition* of the glans, of the prepuce, or of the scrotum, which then assumes a vulviform appearance.

(2) *Penile Hypospadia.*—In this variety of hypospadia the abnormal opening may occupy any point of the lower surface of the penis, included between the peno-scrotal angle and the base of the glans. But there are three points in which it is situated by preference: a short distance from the base of the glans, at the middle part, and at the peno-scrotal angle. The orifice, sometimes normal, sometimes very narrow, and generally of oblong shape, with its long diameter antero-posterior, is surrounded by a muco-cutaneous border which is ordinarily very thin. It is important to properly appreciate the different conditions of the urethra in front of the hypospadic opening. In the immense majority of cases the canal is wanting in front of the abnormal opening. Sometimes it is the upper wall which persists alone in the shape of a groove, bordered by two more or less elevated, erectile lips—a valuable arrangement from the standpoint of treatment; sometimes this wall is itself absent and transformed into a sort of short, resistant ridge, stretched between the base of the glans and the hypospadic opening. The penis presents at the same time a curvature which is already very appreciable in the state of flaccidity, but especially pronounced during erection, and which does not depend alone on the presence of the ridge which I have just described. In such a case the malformation of the urethra is complicated, as J. L. Petit and Bouisson have shown, by an arrest of development of the fibrous tissues which enter into the composition of the cavernous bodies, and by a contraction of these tissues. In certain very rare cases, the canal is in part preserved in front of the opening, and one or other of the following arrangements is observed: (*a*) The meatus appears well formed, and the canal which succeeds it ends in a *cul-de-sac* at a varying depth; (*b*) The canal is present in front of the hypospadia, and ends in a *cul-de-sac* at a greater or less

Fig. 1338.

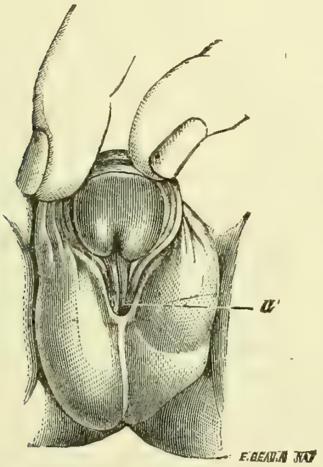
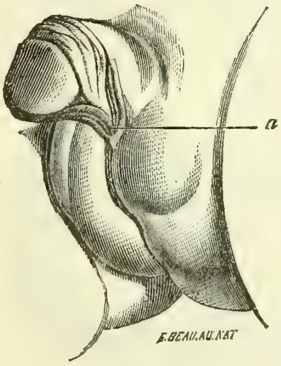


Fig. 1339.

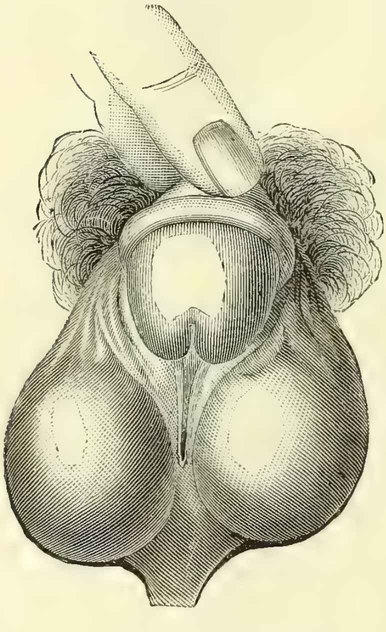


Peno-scrotal hypospadia.

distance from the meatus; (*c*) The urethra and meatus are well formed, and there is a simple congenital fistula of the lower wall of the canal.

(3) *Scrotal and Perineo-scrotal Hypospadia.*—Arrest of development beginning, in this case, at the very outset of the evolution of the external genital organs, the resulting deformity is much more extensive and much more complex. The scrotum, divided in the median line by a more or less deep antero-posterior cleft, is composed of two distinct pockets, each of which may contain a well-formed testicle. But often these organs remain smaller and softer than in the normal state; their descent through the inguinal canal is incomplete, or altogether wanting; and the two pockets, remaining empty, bear an almost perfect resemblance to the labia majora of a woman.

Fig. 1340.



Perineo-scrotal hypospadia.

The penis, often atrophied, is more or less firmly applied against the fissure in the scrotum, whence arises the necessity of elevating the organ, in order to expose and examine the opening in the urethra. The penis being thus elevated, it is seen that the funnel-shaped scrotal cleft is lined with a thin, rosy membrane, mucous in appearance. The urethra opens at the bottom of this infundibulum, and is seen there in the shape of a little slit, elongated vertically and edged with two muco-cutaneous folds, which are prolonged and unite behind, circumscribing a more or less deep depression which suggests to a certain extent the entrance of the vagina. These folds, which simulate the labia minora, approach in front, constituting by their union sometimes a little groove, sometimes a muco-cutaneous ridge which occupies the middle of the lower surface of the penis, and end on each side of the base of the glans.

Although the latter is generally well developed, sometimes even exuberant, the penis is always, especially on its inferior surface, much shorter than in the normal state. It is, moreover, strongly incurvated below, as if elbowed (Bouisson); and this arrangement, which is sometimes met with in penile hypospadia, and which is constant in peno-scrotal and perineo-scrotal hypospadia, is due, not only to the existence of the muco-cutaneous ridge, which extends from the glans to the hypospadic opening, and which represents the absent urethra, but also and especially to the arrest of development of the corpora cavernosa at their inferior part. At this point the fibrous envelope of the corpora cavernosa is found to be thickened, as if retracted, and the most inferior lacunæ considerably reduced in volume; even the septum of the corpora cavernosa seems in certain cases to participate in the contraction, and the knowledge of this fact, due to Bouisson, is of great importance from the standpoint of therapeusis.

In cases of very pronounced malformation, with very deep infundibulum, and with atrophy and retraction of the penis which is firmly applied against the two halves of the scrotum, the conformation of the sexual apparatus presents such a resemblance to that of the feminine type, that the errors which have been committed in regard to the sex of the individual observed are explicable.

Functional Disturbances.—The functional disturbances to which the existence of hypospadia gives rise, vary according to the degree of arrest of development, and according to its simplicity or complexity. They relate to micturition, copulation, and fecundation.

Among glandular hypospadians, without too pronounced curvature of the penis, all these functions are accomplished almost normally. They only show a greater facility to contract gonorrhœa. In penile hypospadia, micturition can still be accomplished quite well, if the patient take pains to lift up the penis in order to thoroughly uncover the opening. Coitus itself is quite often possible, but fecundation is doubtful. In the scrotal and perineo-scrotal variety, the emission of urine is attended by very pronounced inconvenience resulting from the abnormal position of the opening, and from the peculiar disposition of the penis, which is applied against the scrotal cleft. The membranous and bulbous portions of the urethra being well developed, the urine is projected with force, but the fluid escapes in a vicious direction, and the stream, breaking against the penis, sprinkles on all sides, so that patients afflicted with perineo-scrotal hypospadia are obliged to squat down, like women, in order to urinate, on pain of inundating their garments. If the urinary functions, simply embarrassed, are after all performed quite easily, it is different with the genital functions, which are completely obstructed. At the moment of erection, the penis, instead of straightening itself and taking a rectilinear direction, is incurvated at its lower part, in such a way that the glans is carried more and more backwards, and is hidden in the fissure of the scrotum. It will be understood that in such conditions copulation is absolutely impossible. Ejaculation takes place, but, for reasons already indicated in connection with the emission of urine, remains essentially unfecundating.

Diagnosis.—Hypospadia is generally very easy to recognize, and the parts are hardly uncovered before the diagnosis is made. There are, however, certain circumstances, in which the solution of the problem may present some difficulty. Thus it has been possible to believe there was present a simple imperforation of the penis in certain cases of penile hypospadia, with an abnormal opening which was very narrow or hard to discover. But it is enough, in order to escape such an error, to make the patient urinate. Congenital hypospadia might also be confounded with a splitting of the penis happening in consequence of a traumatism. I will cite in this connection the case reported by Chopart, in which an individual split his urethra gradually from the meatus to the scrotum; and I have myself seen a case of traumatic fistula, situated on the lower surface of the penis, which simulated hypospadia. But the external appearance, on the one hand, and the history, on the other, make it possible always to recognize the true nature of the deformity.

A much more delicate question, raised by the diagnostic study of this deformity, is that which treats of the determination of sex in individuals affected with perineo-scrotal hypospadia. When the testicles have completed their descent through the inguinal rings, their presence in the folds of the bifid scrotum will disperse all doubt. But it is quite different in cases in which these organs have not descended into the scrotum. Not only does their absence cause the two scrotal halves to acquire a more marked resemblance to the labia majora of a woman, but, further, it impresses the whole organism with forms and characteristics which depart widely from the masculine type. However, all mistake in this connection may be avoided by carefully palpating the abdomen, and by combining rectal exploration and sounding, with the object of determining the absence of the uterus, and of discovering in its place the prostate, which in cases of perineal hypospadia is neither atrophied nor deformed.

Hypospadia once recognized, it is important to carefully investigate the conditions which may influence the operative indications: presence or absence of an anterior urethra; degree and nature of the incurvation; presence or absence of the testicles; well-marked atrophy of the penis.

Prognosis.—If glandular hypospadia induces in the great majority of cases only trifling inconveniences, the existence of a penile, scrotal, or perineoscrotal hypospadia, places the individual who is afflicted with this vice of conformation in a most painful physical and moral situation, which gives to the variety we are considering an altogether peculiar gravity; a gravity, however, which has been much diminished since it has been shown that perineoscrotal hypospadia, which constitutes the most advanced degree of the malformation, far from being beyond the resources of art, as was formerly believed, is amenable to surgical relief, and that individuals who are afflicted with it may have restored, at the same time with symmetry of external form, the faculty of accomplishing normally their genital and urinary functions.

Treatment.—A certain number of attempts were made by the older surgeons, with the object of forming summarily an artificial canal in the substance of the glans and cavernous bodies, by means of a red hot iron or trocar. These rude and barbarous procedures furnish a remedy to none of the concomitant malformations, and insure, as a necessary and inevitable consequence, stricture of the new canal, and finally its obliteration.

Bouisson first dealt practically with the question of the surgical treatment of hypospadia, and gave this question a considerable impetus. He showed that it was necessary, before thinking of making a new canal from the hypospadic opening to the extremity of the glans, to place the penis in a condition to accomplish its functions by effecting the disappearance of the incurvation of this organ, which helps to make the emission of urine and spermatic fluid troublesome, and obstructs coitus more or less completely. For this he advised, first, to incise the ridge which represents the urethra transversely, and, as this operation was generally insufficient to completely straighten the penis, to practise at a later time subcutaneous section of the fibrous envelope, and of the septum of the corpora cavernosa. In regard to the formation of a new canal, Professor Bouisson comprehended perfectly that, in cases in which the urethra was wanting over a considerable extent of the lower surface of the penis, it was necessary to have recourse to urethroplasty, that is to say, to borrowing tegumentary flaps from the neighboring parts; he further insisted on the necessity of finding flaps which could be reversed in such a manner as to present their epidermic surface to the cavity of the new canal, in order to prevent its consecutive contraction.

I shall not dwell on the operative procedure adopted by Bouisson, and followed by failure in the single case in which it was put into practice, and I shall only mention that of Moutet, which appears to me to complicate the preceding one without adding to its chances of success. The operation practised in 1874, by Théophile Anger, on a young man of sixteen years, affected with penile or peno-scrotal hypospadia, effected, on the contrary, a complete cure. I shall not repeat here the objections which may be urged against the procedure adopted by this surgeon, a procedure which was absolutely identical with that which, as early as 1869, Professor Thiersch, of Leipsic, had described and practised in a case of epispadia, contenting myself with referring my readers to the first of the two papers which I have published upon this subject.[1]

I have now reached the method which is personal to myself, and which, applied to the treatment of hypospadia, even when most complicated, always succeeds, provided that time and patience be given to it. This method has for its principle to proceed with the reparation in successive stages, which may be divided in the following manner: (1) Straightening the penis; (2) Creation of a new urethral canal from the extremity of the glans to the neighborhood of the hypospadic opening, which should be left untouched to give exit to the urine until the time of the definitive formation of the new canal; (3) Junction of the two portions of the urethral canal.

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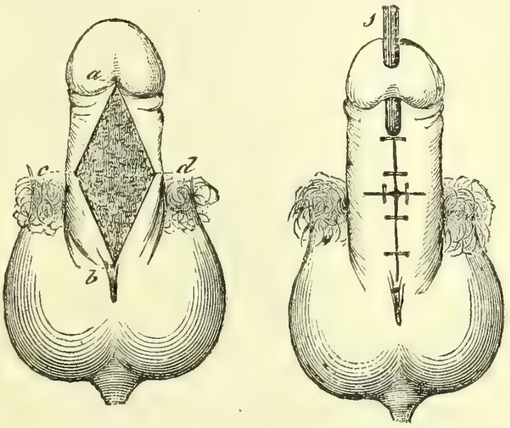
[1] Archives Générales de Médecine, Mai et Juin, 1874.

First stage: Straightening the Penis.—I have already indicated the manner in which Bouisson advised to proceed with this straightening, and I have no objection to offer to the method of this surgeon, if it be not to the blind manner in which the section is made, and consequently the impossibility of knowing exactly what has been done. It has therefore appeared to me more simple, and at the same time more sure, to incise transversely and by an open wound the ridge which unites the glans to the hypospadic opening, and to carry this incision as deeply as is necessary to obtain complete straightening of the penis. (Fig. 1342.) I have, further, convinced myself by experience that a very considerable thickness of the corpora cavernosa may be incised with impunity, and in one case in particular, one of the gravest on which I have had to operate, in a young man twenty years old whose penis was reduced to very small proportions by reason of an extremely pronounced curvature, I had to penetrate very deep into the substance of the corpora cavernosa, in order to restore to the penis sufficient length and straightness.

Fig. 1341. Fig. 1342.



Section of the subpenile band and straightening of the penis.

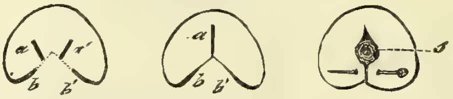
This preliminary operation may in some cases be omitted, if the curvature of the penis be absent or very slightly marked, and I will cite in this connection the case of an individual aged twenty-five years, affected with perineoscrotal hypospadia with quite pronounced incurvation of the penis, who had himself fulfilled this indication by releasing his penis from its inferior attachments by successive sections.

One ought, before passing to the second stage, that is to say, before thinking of making a new urethra, to wait a sufficient time to be assured that no secondary contraction will occur which may restore the incurvation of the penis. By fixing this time at six or eight months, such an accident will I think surely be avoided.

Second stage: Formation of a new Canal from the Meatus to the Neighborhood of the Hypospadic Opening.—The reconstruction of the meatus should first fix the attention of the surgeon. In none of the previous methods of procedure was much attention paid to this special point. In the patient of Théophile Anger, the only one who recovered from his infirmity, the opening of the new urethra was situated below the glans, and formed a simple cutaneous prominence. Such an imperfection has, in my opinion, much more importance than would at first thought be believed. Apart from the want of external symmetry, the absence of a meatus hollowed out of the thickness of the glans causes real inconvenience, especially in regard to ejaculation. The new urethra, devoid of erectile tissue in all its penile portion and having very slightly resistant walls, cannot do its share in the discharge of the semen, which escapes by an opening likewise flaccid, and situated moreover underneath the glans. In these conditions, projection of the semen must be almost wanting, or at least must take place in a vicious direction, and consequently the chances of fecundation must be very limited. On the contrary, if there is at the extremity of the penis a portion of the canal hollowed out of the substance of the glans, the spermatic fluid, traversing on its issue an orifice with walls rendered rigid and resistant by erection, will be projected further and in a suitable direction.

This restoration of the meatus may be practised at the same time as the operation designed to straighten the penis, as is shown in Fig. 1342. This mode of procedure, which may shorten the whole duration of the treatment, has the further advantage of furnishing a sort of starting point for the new canal, and of supplying a support to the catheter around which the canal should be moulded. The following is the way in which the operation is executed (Fig. 1343). A commencement is made by vivifying at their lower parts, the two lips *bb′* of the depression which represents the meatus, and by placing between these two lips a small catheter tip, over which the vivified parts are united by one or two points of suture. If the depression be too shallow to permit the formation of a large enough meatus, two small lateral incisions *aa′*, or a median incision *a*, made in the substance of the glans, will make it possible to introduce the tip of a catheter of proper size and to apply the suture below it.

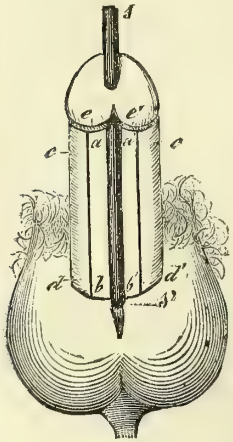
Fig. 1343.



Restoration of the urinary meatus.

In regard to the formation of a new canal, the following is the method of procedure which I have devised: The penis being held up (Fig. 1344), there is made on its lower surface, on each side of the median line and some millimetres outside of this line, a longitudinal incision *ab*, *a′b′*, extending from the base of the glans to within one centimetre, or even half a centimetre, of the hypospadic opening. When this is done, the internal lip of the incision is to be slightly dissected up, so as to be inclined inward over the catheter, but without attempting to cover it entirely. On the other hand, the external lip of each incision is to be dissected freely, so as to draw toward the median line the skin of the lateral parts of the penis. The cutaneous surface of the inner flaps is thus turned toward the cavity of the canal, whilst their raw surface is turned toward the outside and covered by the raw surface of the two external flaps. In this way the catheter is in reality not wholly covered by a cutaneous surface, but I have been able to convince myself that no

Fig. 1344.

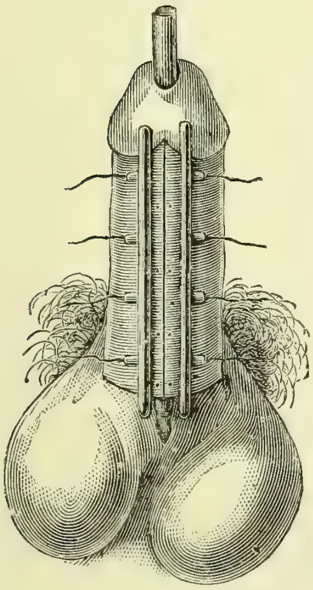


Formation of the new canal.

inconvenience to the new canal results from this; in fact, the cicatricial surface is almost linear, and it suffices, to avoid ulterior contraction, that half the canal should have a cutaneous surface.

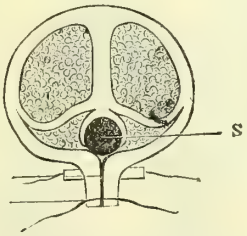
Nothing is now left but to unite in the median line the flaps thus displaced; and this is easily done by means of the quilled suture, which I apply in the following manner, in order to make it as efficacious as possible. I employ very fine silver wire, and each point of suture, at a distance of about half a centimetre, is made of a single wire, and not double as in the ordinary quilled suture. The ends of each wire are passed at suitable distances through holes made in small leaden tubes, and, when the constriction is deemed sufficient, the wires are fastened with perforated shot. The tracks of these single wires are almost imperceptible, and they do not make, like the ordinary quilled suture with double threads, large openings at the point of entrance and exit. If the surfaces approximated by this suture leave a slight separation externally, union may be completed by a few points of interrupted suture, superficially placed. (Figs. 1345 and 1346.)

Fig. 1345.



Modified quill suture

Fig. 1346.



Section showing arrangement of deep (*a*) and superficial (*b*) sutures.

Thanks to this method of suture, which insures perfectly exact contact, and which is solid enough to resist erection, the formation of the new canal is much more easy, and may succeed at the first attempt through its entire extent. This fortunate result has been obtained in several of those on whom I have operated. In any case, if there remain some points where union has failed, it is easy to remedy this by one or more supplementary operations.

Third stage: Junction of the two Portions of the Canal.—When it is well assured that the new canal presents no tendency to contraction, and that it is in an altogether satisfactory condition, it remains to join the two portions of the urethra by obliteration of the hypospadic fistula. The circumference of the abnormal opening having been freely vivified for an extent of nearly a centimetre, and a catheter having afterwards been introduced by the new canal into the bladder, the same method of suture as in the preceding stage is applied, that is to say, the quilled suture with single silver wires, passing through two leaden tubes pierced with holes, and fastened at each side with perforated shot.

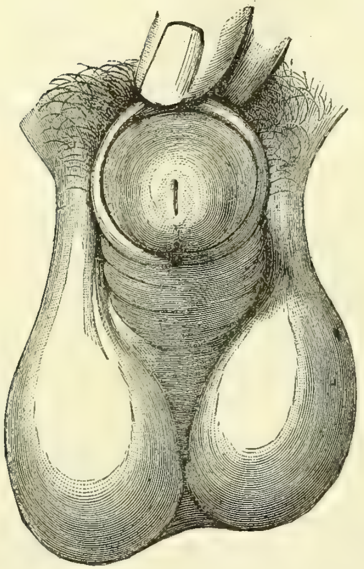
A very interesting and truly difficult question in the execution of the third stage concerns the method of evacuating the urine. I have always done very well by the employment of a retained catheter, left constantly open, so that the urine may escape drop by drop as soon as it reaches the bladder.

At the end of two or three days I remove the catheter and permit the patients to micturate without assistance, placing themselves on their hands and knees so as to facilitate as much as possible the flow of urine.

The final result of the operations which I have just described is as satisfactory as possible.

As regards external shape, it is, so to speak, impossible to suspect the previous existence of so considerable a deformity, and in some of my patients it is hard to find the trace of the operations which they have undergone. From the functional standpoint, the results are not less remarkable. The voiding of urine, having become normal, takes place with the greatest facility, by a large and strong stream. The only trouble complained of by those operated upon consists in the lingering of a few drops of urine in the newly made portion of the canal; but it suffices, in order to cause its expulsion, to make with the fingers, after each micturition, light pressure from behind forwards along the track of the urethra. Erection, which before the operation had no effect but to bend the penis and carry the end of the glans backwards, has become almost completely rectilinear, and easily permits the accomplishment of coitus. Ejaculation is effected in almost the same conditions as the emission of urine, so well that two of those on whom I have operated have married, and have been able to fulfil their marital duties satisfactorily, having become fathers shortly after entering wedlock.

Fig. 1347.



Definitive result of operation for hypospadia; compare with Fig. 1342.

Epispadia.—Epispadia is a vice of conformation characterized by a more or less extensive division of the upper wall of the urethra, accompanied or not by ectopion of this canal. The term epispadia was introduced into science by Chaussier and Duméril.

Etiology and Pathogenesis.—The etiology of epispadia is as obscure as that of other vices of conformation of the urethra; and heredity is the only cause to which may be conceded an incontestable influence in its development. Various opinions have been expressed by authors in regard to the pathogenesis of this malformation. According to Richet and A. Richard, epispadia is the consequence of an arrest of development which prevents the corpora cavernosa from uniting in the median line; that is, a fissure of the corpora cavernosa. This view was combated by Dolbeau with arguments based on clinical observation and on the results furnished by two autopsies. This author begins by separating *glandular* epispadia, or simple superior urethral fissure, from complete or incomplete *penile* epispadia, which is always accompanied by ectopion of the urethra.

Arrest of development suffices to explain the pathogenesis of glandular epispadia. The glans, which is of late formation, is constituted by the reflection upwards and backwards of the two vascular fasciculi which form the spongy portion of the urethra; and it suffices that these two fasciculi should remain separated, in order that the urethra should remain open on its upper surface, and that epispadia of the glans should result.

For cases in which the fissure extends beyond the limits of this organ, the following is the explanation proposed by Dolbeau :—

> Let us admit, he says in substance, that the corpora cavernosa, or rather the superior external genital nodules of Coste, instead of uniting above, unite below so as to intercept between them a groove which is exceptionally superposed upon the corpora cavernosa instead of being subjacent to them ; if the borders of this groove unite in the median line, the canal will be formed, but upon the back of the penis. If, on the contrary, union fails to take place, the subject will be afflicted with penile epispadia complicated with inversion of the urethra.

According to Trélat, the malformation depends upon retardation of the evolution of the external genital nodules, which would not exactly coincide with that of the internal genital organs. The urethra, gradually withdrawing from the anus, would soon be between and above the two external genital nodules, which thereafter could only unite below.

I shall describe only three varieties or degrees of epispadia: *glandular* epispadia, in which the division remains limited to the glans; *spongio-glandular* epispadia, in which it involves a variable extent of the spongy portion ; and, finally, *complete* epispadia, in which it extends to the whole spongy portion from the extremity of the glans to the pubes.

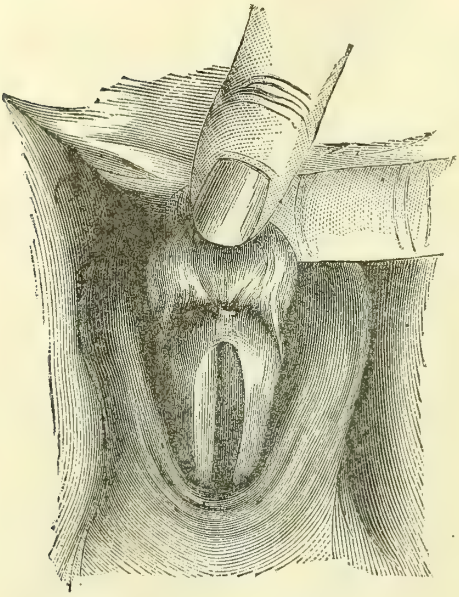
(1) *Glandular Epispadia.*—In this very rare variety of the vice of conformation which we are studying, the superior or dorsal surface of the glans is divided for the greater part of its length. Here there is seen a median groove, broad and deep, which represents the inferior wall of the glandular part of the urethra, and is continuous posteriorly, by a sort of infundibulum, with the spongy portion of this canal. There is in the median line a pretty deep antero-posterior furrow; on each side of this furrow a little crest, formed by the doubled mucous membrane of the spongy tissue ; outside of this crest a more or less marked furrow ; and, still further outside, the two halves of the glans. Upon the prolongation of the median furrow is the frænum, the insertion of which is found much further in front than in the normal state. The penis is short, voluminous, and, as it were, spread out. Further, it is necessary in order to observe the condition of the glans well, to hold the parts asunder with the fingers. In the state of repose, the furrows are effaced by the approximation of their edges, and appear only in the form of three lines, at the bottom of a scooped-out portion of the glans.

(2) *Spongio-glandular Epispadia.*—The division occupies the whole glans and a more or less extensive portion of the spongy region. The groove thus formed, contracted at the position of the meatus, but spread out toward the fossa navicularis, is continuous by a sort of infundibulum with the remaining portion of the urethra, which is found with its normal characteristics. The mucous membrane which covers this groove is insensibly blended with the skin of the lateral parts of the penis, and in it are seen the orifices of a number of urethral lucunæ. The penis is short and voluminous. The corpora cavernosa are completely united, and do not show any trace of the urethra on their lower surface.

(3) *Complete Epispadia.*—In this the penis exhibits a most pronounced malformation. It is short, recurved, and drawn upwards and backwards, so that its upper surface is found in contact with the abdominal wall, whilst the lower one looks directly forwards and even a little upwards. There is almost always some twisting of the organ. The prepuce is triangular, thick, and exuberant, although reduced to its lower half. It is necessary, in order to examine the upper surface, to depress the penis strongly. Then there is

seen (Fig. 1348) a more or less deep groove, which begins at the glans, and ends deep under the pubic arch. At this point there is a sort of infundibulum, formed above by the skin of the abdominal wall, which passes under the pubis assuming little by little the appearance of a mucous membrane, and below by the urethral groove. This infundibulum leads to the orifice by which the urine escapes, limited below by the most retracted portion of the urethral groove, and above by a mucocutaneous fold, in the shape of a crescent with its concavity downwards, and continuous by its extremities with the skin which covers the lateral parts of the penis, and the mucous lining of the membranous portion of the urethra. The appearance of the groove varies at different points. At the level of the glans, vestiges of the fossa navicularis are found, a sort of fusiform depression with three longitudinal ridges, one of which is median and the other two lateral, separated by two folds of the mucous membrane. Approaching the bladder the mucous membrane assumes a deeper color; it presents a number of lacunæ of Morgagni, and is insensibly blended with the skin which covers the penis. The well-formed corpora cavernosa are united in the median line, especially at their lower surface. They are sometimes separated at their upper surface, and are often atrophied. In a specimen which Dolbeau had the opportunity to dissect and inject, he found an arrest of development of the spongio-vascular portions of the urethra, of which only traces remained. The rest of the canal was normally formed.

Fig. 1348.



Complete epispadia.

Functional Disturbances.—When epispadia is incomplete, the functions are usually little disturbed. Even complete epispadia is not necessarily accompanied by a continuous and involuntary escape of urine. Some patients can hold it, but they have an imperfect stream, divided or scattering, which soils their clothing and wets the neighboring parts. An epispadian seen by Chopart, was obliged to urinate squatting, and the liquid escaped in a stream of parabolic curve. But usually there is more or less complete incontinence of urine, the true cause of which is not yet perfectly understood. When the penis is drawn away from the abdominal wall, the urine, instead of dribbling out, escapes by a stream, which seems to indicate a certain accumulation of this liquid in the bladder. In some patients incontinence ceases as soon as they assume a horizontal position. It is a curious fact that this incontinence tends to disappear under the influence of an autoplastic operation upon the penis, even at some distance from the bladder. Dolbeau explains this fact by asserting that the presence of a retained catheter restores to the distended and sluggish bladder its normal dimensions and its contractility. In this way the patient recovers both the sensation of the need to urinate, and the power to void his urine voluntarily. It seems to me that there is here rather a reflex action affecting the sphincter of the bladder, which is reinforced by the construction of the new canal. In regard to the genital functions, erections occur, although feeble ones, even in complete epispadia; but the shape of the penis renders copulation imperfect, and fecundation impossible.

Complications.—Exstrophy of the bladder, which quite often accompanies complete epispadia, has been erroneously considered as an extreme degree of this malformation. But they are in reality two perfectly distinct vices of conformation, following, the one an arrest of development of the external, and the other an arrest of development of the internal genital organs. Nevertheless, exstrophy of the bladder has an obvious influence upon fissure of the whole length of the upper wall of the urethra. *Separation of the pubic bones* is quite a frequent complication of the vice of conformation which we are studying, and it is easy to recognize it in the living by means of simple palpation. This condition, which may be accompanied by atrophy of the two bones, reduces the patient to a very lamentable condition, because it enlarges the epispadic opening, and prevents the formation of the sphincter. From this there usually results complete and incurable incontinence. Separation of the pubic bones is sometimes accompanied by hernia of a portion of the bladder through the epispadic opening, without true exstrophy of this organ. Then there is seen, at the level of the pubic region, a tumor, the size of a nut or small apple, soft, livid, made up of mucous membrane, covered with thinned skin, and reducible by pressure. Finally, let me mention, to conclude what refers to the complications of epispadia, *atrophy of one of the testicles*, and *cryptorchidism*.

Treatment.—The appliances devised for the purpose of remedying without operation the only truly serious disturbance produced by the existence of epispadia—incontinence of urine—accomplish only in a very imperfect manner the capital indication of collecting the urine as fast as it escapes from the epispadic opening. Surgical interference, on the contrary, has succeeded in these latter times, not only in delivering the unfortunate epispadian from a disgusting infirmity, but also in restoring to him an external shape of almost perfect symmetry.

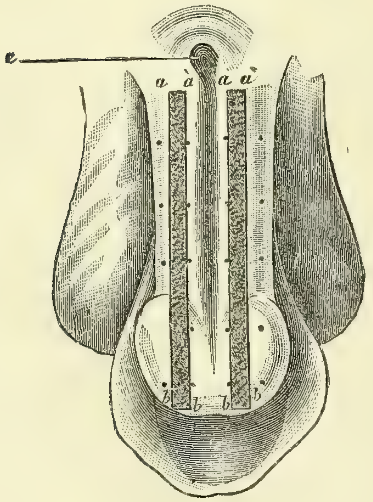
Dieffenbach first attempted, in 1837—without success, however—to cure epispadia by an operation, and Blandin made, some years afterwards, a new attempt which was no more fortunate. The operative procedure devised by Nélaton in 1852, afterwards adopted and slightly modified by Dolbeau, although less imperfect than the preceding, furnished only incomplete results. The new canal, formed of exclusively cutaneous flaps, was of exaggerated dimensions, and only rudely suggested the normal urethra. Professor Thiersch, of Leipsic, effected considerable progress by formulating as a principle, as I myself had done for the treatment of hypospadia, to proceed to the repair of epispadia in a series of successive stages. I shall not dwell, however, on the method of this surgeon, by which I have been guided up to a certain point, as well as by that which I have myself devised for the treatment of hypospadia.

The following is the procedure which I advise for the surgical treatment of epispadia; it may be divided into three stages, comprising: (1) Straightening the penis. (2) Formation of a new canal from the extremity of the glans to the neighborhood of the epispadic opening, which should be let alone as long as the new canal is not wholly formed. (3) Finally, junction of the two portions of the canal.

First stage: Straightening the Penis.—It is sometimes hard to obtain perfect lengthening and straightening of the penis, because of the considerable atrophy of the corpora cavernosa at their upper part. I attempt, as far as possible, to fulfil this first indication by means of single or multiple incisions, penetrating more or less deeply into the corpora cavernosa in the neighborhood of the pubis. I have been able to ascertain, in a number of those on whom I have operated, that this straightening of the penis, even when it was at first incomplete, was completed afterwards in consequence of the development of the genital organ.

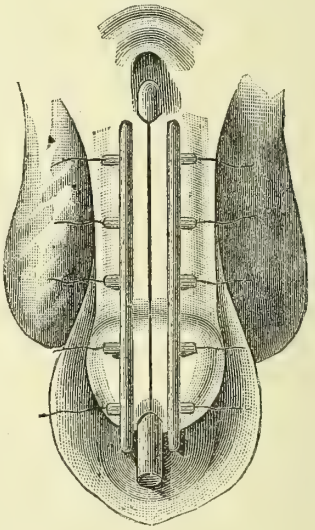
Second stage: Formation of the new Canal from the Extremity of the Glans to the Neighborhood of the Epispadic Opening.—In place of making use, as in the operation of Thiersch, of cutaneous flaps taken from the upper and lateral parts of the penis, I have endeavored to form a canal sensibly approaching the normal conditions, by dispensing with any kind of flaps, and by forming this canal almost exclusively at the expense of the corpus spongiosum and corpora cavernosa of the penis. In epispadians, indeed, the corpora cavernosa are united by a fibrous septum, often quite thin, and reflected from the bulb of the urethra and from the skin. By depressing this septum from above downwards, the corpora cavernosa are seen to approach one another, and to form a more or less deep groove, which is capable of lodging a catheter, and is well fitted to form a true canal by the union above the catheter of its upper margins. If its depth appear insufficient, an incision made in the median line makes it possible to increase it as much as is necessary. When this is done, I make, on the upper surface of the penis (Fig. 1349), on each side of the median line and at a sufficient distance from it, a vivification, quadrilateral in shape, *aa′ bb′*, about half a centimetre in breadth, and extending from the extremity of the glans to the neighborhood of the epispadic opening. I afterwards secure perfect apposition of the vivified surfaces by means of the quilled suture with single wire, which I have described in connection with hypospadia. (Figs. 1350 and 1351.)

Fig. 1349.



Formation of new canal; shows raw surfaces and position of sutures.

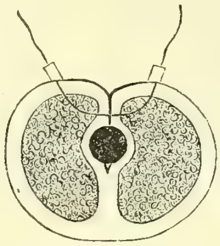
Fig. 1350.



Modified quilled suture.

Although it is admissible to attempt to secure at one time the complete reproduction of the canal, from the glans to the neighborhood of the epispadic opening, I nevertheless advise, as in the case of hypospadia, to attempt to construct first the glandular portion of the new canal, at the same time that the straightening of the penis is effected. This way of doing has the advantage, if successful, of facilitating the second stage, which then consists only in the reproduction of the penile portion of the canal, from the base of the glans to the level of the epispadic opening.

Fig. 1351.

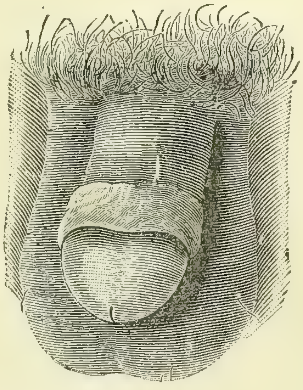


Section showing the sutures applied.

I have found that it contributes to the success of this second stage to employ a retained catheter, passing through the epispadic opening, and intended to divert the urine, which, without this precaution and on account of the incontinence from which most epispadians suffer, would constantly bathe the wounds on the dorsal surface of the penis, and might prevent their union.

Before proceeding to the third stage, that is to say, the junction of the two portions of the canal, I have in a number of cases adopted a little complementary operation, which has for its object to perfect the result as regards symmetry of form. In most epispadians the prepuce is of exaggerated dimensions, and forms at the lower surface of the penis a sort of cutaneous prolongation, which is very disfiguring, and which may even become a hindrance to coitus. On the other hand, after the formation of the new canal according to my method, the skin of the dorsal surface is extremely thin and of a rosy color, somewhat like that of the mucous membrane, and disagreeable in appearance. I have obviated at one time both these defects, by transplanting the exuberant prepuce above the glans, as Thiersch also has advised with a slightly different object, and by making use of it to cover the upper surface of the penis with normal skin. To do this, after having vivified for a suitable distance the upper surfaces of the corpora cavernosa, I make, in the thickness of the prepuce and at the base of the glans, a large buttonhole, through which I pass the head of the penis; and afterwards the two folds of the prepuce, having been freed by dissection, are applied to its dorsal surface. It only requires a few points of suture on the corona of the glans to fix the prepuce in this new position. This little complementary operation has, besides, the advantage of permitting the occlusion of any points which may have escaped union after the previous operation.

Fig. 1352.



Definitive result of operation for epispadia: compare with Fig. 0044.

Third stage: Junction of the two Portions of the Canal.—When the new canal has been carried up to the neighborhood of the epispadic opening, the latter is seen in the form of an infundibuliform fistula, which burrows deeply behind the pubis, and which may be easily obliterated without the help of any flap.

It is sufficient, in fact, to practise a free vivification, which is carried as far as possible along the walls of this infundibulum, and then to approximate the opposite surfaces by means of a few points of shotted suture. If union is not complete on the first occasion, the operation may be repeated, so to speak, indefinitely, until the final occlusion of the fistula.

As regards restoration of the external shape, the procedure which I have just described furnishes a truly admirable result (Fig. 1352), and one which is incomparably superior to that secured by the operations of Nélaton and Dolbeau, or even by that of Thiersch.

In regard to the urinary functions, incontinence, as I have already said, is ameliorated after the earliest operations. From being continuous, as it was at first, it becomes intermittent, and ends by disappearing completely. A number of those on whom I have operated, whose cure was finished a long time ago, hold their water day and night; micturition is voluntary, and the urine is projected with force.

Finally, the only patient who has been able to furnish me with information on this point, acquired, after the operation, the faculty of practising coitus, and his genital functions are accomplished in an absolutely normal manner.

CONDITIONS WHICH MAY COMPLICATE DISEASES OF THE URETHRA.

URINARY INFILTRATION.—We say that there is infiltration of urine whenever this liquid, leaving its natural passages, escapes into the cellular tissue, and tends to invade progressively the neighboring regions.

Etiology and Pathogenesis.—From the terms of this definition it is easy to perceive that urinary infiltration may be produced under the influence of very many causes, and may occupy extremely various situations. When the *kidney* has been ruptured by a traumatism, or when a large and old calculus inflames and perforates this organ from within outwards, a greater or less quantity of urine will be extravasated into the perinephric cellular tissue, and a urinary infiltration, thus occurring in an unusual situation, will lead to a *perinephritis* with a special course. Ruptures of the *bladder*, either traumatic or spontaneous, and accidental or surgical wounds of this organ, cause the appearance in the pelvic cellular tissue of analogous lesions, and it is hardly necessary to recall here how many methods, since the time of Frère Côme, have been employed by surgeons to prevent infiltration of urine after suprapubic lithotomy. But it is lesions of the *urethra* which are the most frequent causes of urinary infiltration. If they are situated in the prostatic urethra, like the incisions of lateral lithotomy, and like some false passages in old men, they cause infiltration of the upper part of the perineum; they cause it, on the other hand, in the lower part, between the triangular ligament and the superficial fascia, whenever, as is usually the case, they are situated in the anterior urethra, at the level of the perineo-bulbar portion of this canal. If rupture of the urethra in consequence of falling astride on any object, may be the cause of urinary infiltration, more frequently, and in almost all the cases in which it has been observed, it supervenes upon an old and neglected stricture. The mode of production of this long-discussed accident has been cleared up in a remarkable manner by Voillemier, and I have sufficiently described it in the pages which treat of organic stricture of the urethra. I will only recall the fact that this rupture of the urethra is due, on the one hand, to a previous alteration of the canal behind the stricture, and, on the other hand, to energetic contractions of the bladder.

On account of this latter condition, it will be understood that urine may be extravasated in large quantity, and that it may infiltrate, to a greater or less distance, the substance of the tissues, since it is not restrained by any obstacle. Still, it is necessary that it should have caused quite a large laceration of the canal, as otherwise it filters little by little into the cellular tissue, and sets up before it an adhesive inflammation which limits its progress, urinary abscess then following.

Is the greater or less quantity of urine extravasated into the cellular tissue the only cause of the production of infiltration in a certain number of cases, and of urinary pouches or urinary abscesses in others? Relying upon the opinions of his teacher, Professor Verneuil, Muron[1] devoted his inaugural thesis to the study of this point of pathogenesis. From the examination of cases, and from a certain number of experiments made for the purpose of testing the correctness of the views of Simon and Menzel, who believed in the innocuousness of the retention of acid urine in the tissues, Muron concluded that the quality of the extravasated urine, as well as that of the tissues into which it was extravasated, ought to be considered as playing an important part in the production of one result or the other. "Urinary pouches," he says, "do not exist and cannot exist except when the tissues are healthy and the urinary liquid has a feeble osmotic power. Urinary abscesses are produced whenever a small quantity of urine passes into the cellular tissue, upon condition that this liquid is rich in acid or alkaline salts. Urinary infiltration results in the first place from hypertrophy of the bladder, enabling it to expel the urinary liquid forcibly. It will be of moderate intensity if the liquid be acid, but, on the contrary, it will attain considerable proportions if the liquid be alkaline by ammoniacal decomposition, or if the organism itself be altered."

Although applicable to a certain number of cases, these conclusions, formulated in a sufficiently categorical manner, are certainly exaggerated. I have, for my own part, seen numerous examples of urethral ruptures which, happening to subjects who were vigorous and exempt from any diathesis, have been followed by extensive urinary infiltration; and the fact must not be lost sight of that, whatever may be the cause which first gives rise to it, this infiltration is often preceded in its development by a urinary tumor or by a urinary abscess.

Symptomatology.—Although, wherever it is produced, infiltration of urine determines in its passage inflammation and mortification of the cellular tissue, the local symptoms by which it is manifested vary with its situation and extent.

If it occupies, as is usually the case, the lower space of the perineum, and if it occurs in a patient affected with an old urethral stricture, its occurrence is usually announced by an immediate sensation of relief, by a peculiar feeling of comfort, which suddenly succeeds the pains caused by persistent dysuria. Immediately, and at the same time that the hand applied to the hypogastrium perceives a diminution of the protrusion which the distended bladder formed above the pubes, there is distinguished in the perineum the appearance of a tumefaction which shows day by day a remarkable tendency to increase. Resulting from the extravasation of urine, which, hemmed in above by the upper layer of the triangular ligament, and below by the superficial layer, can only advance forward, this swelling, at first situated in the anterior perineal region, rapidly invades the scrotum and the penis. The scrotum increases considerably in volume, and sometimes becomes as large as the head of a fœtus; the penis and the prepuce, gorged with urine, are in a condition of œdema like that which is seen in individuals affected with anasarca. Limited for a while to these regions, the tumefaction is not long in gaining the abdominal wall, passing above the pubes, and in extending to the region of the buttocks and the upper parts of the thighs, after having passed around the iliac crests. It may even, if the surgeon does not actively interfere, go further still and reach the lumbar and axillary regions.

Although it constitutes the first local symptom of infiltration of urine, tumefaction is not long in changing its character, and in being accompanied with various complications. To the soft and painless œdema which characterizes it at the outset, soon succeeds a painful œdema, more resistant to the touch; the skin at the level of the various invaded points loses its normal appearance, becomes hot and shining, and is covered with an erysipelatous redness. Soon, in a number of places, spots are seen to appear, at first copper colored, but afterwards violaceous and dusky, and light pressure on their surface gives the sensation of fine crepitation, resulting from the collision of the gases which are largely developed in the centre of the mortified parts. Little by little these eschars separate from the neighboring parts, and when they are detached they leave behind them irregular openings, through which the mortified cellular tissue is eliminated in the form of grayish filaments and masses. Large surfaces may thus be despoiled of their integuments, and the testicles and the penis may, upon the falling off of the eschars, be found exposed and deprived of their enveloping membranes.

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[1] Pathogénie de l'Infiltration de l'Urine. Thèse de Paris, 1872.

Altogether different are the symptomatic characteristics of infiltration when, having its origin in a lesion of the prostatic urethra, it occurs in the upper perineal space. Limited above by the pelvic fascia and below by the triangular ligament, the urine can then escape easily, only backwards, on the sides of the rectum, and into the ischio-rectal fossæ. Then it is in the posterior part of the perineal region that there is found a diffuse doughiness, rather than a true tumor, and afterwards gangrenous patches, the separation of which by sloughing leaves behind deep and extensive gaps.

If the local symptoms of urinary infiltration vary with its situation, the general symptoms by which it is accompanied are always, except as to intensity, very much the same. The irruption of urine into the cellular tissue is marked by a chill, sometimes single, but oftener repeated with variable violence. At the same time the pulse is quickened, becomes small, and the patient falls rapidly into profound adynamia, to which he may succumb, but from which he usually rallies if the surgeon interferes actively, or at the moment of the spontaneous fall of the eschars. If the ravages have not been too great, when the mortified parts are once detached from the healthy parts, healthy suppuration may be established, and the gaps may rapidly fill up, leaving in their place only one or more fistulæ. Too often, unfortunately, this amelioration of the general condition is only temporary, and, after cicatrization seems to be progressing, it is not uncommon to see patients, worn out by long and profuse suppuration, succumb to hectic fever when everything seemed to justify the hope of their speedy recovery.

Diagnosis.—The diagnosis of infiltration of urine is generally easy. Perhaps on a superficial examination this affection may at first be mistaken for diffuse phlegmon or for erysipelas; but the history, gathered by interrogating the patient, will usually make it impossible to long persist in such an error. More difficult to recognize is infiltration which has its seat in the pelvic cellular tissue. The sudden appearance, in a patient affected with a urinary lesion, of hiccough, of greenish vomit, and of cold sweats, with a frequent and small pulse, may of itself put the surgeon on the track of the diagnosis.

Treatment.—Two principal indications present themselves in the treatment of urinary infiltration. It is necessary: 1st, to give exit to the infiltrated urine; 2d, to re-establish the natural flow of this liquid.

In dealing with an infiltration at its outset, when there is as yet only a perineal tumor, it is wise to make an incision at the very spot of the infiltration, and at the presumable level of the tear in the canal. This incision should, therefore, be median, and to be efficacious it should extend in depth to the very focus of the infiltration. In infiltrations which are already extensive, such an intervention would be insufficient, and to the deep median incision should be added incisions of different situations and depths, intended to facilitate the escape of the infiltrated urine and of the shreds of sphacelated cellular tissue. Whatever may be the number of incisions which one is thus compelled to make, it is necessary to take care to space them sufficiently, and to arrange them in such a manner as to prevent as much as possible gangrene of the portions of skin which separate them. The application of emollient cataplasms, intended to modify inflammation and to facilitate the fall of the eschars by softening them, ought to follow this first surgical intervention, and, when the wounds are clean, ordinary antiseptic dressings ought to be brought into requisition to hasten their cicatrization.

Having thus taken the steps necessary to arrest the course of the infiltration, the surgeon should occupy himself with re-establishing the normal flow of urine. At the end of a few days he should attempt for this purpose to introduce a catheter into the bladder, which can usually be done without much difficulty; but if, in spite of all his efforts, he should not succeed in this, he should resolve to practise external urethrotomy, the re-establishment of the continuity of the canal constituting the only method which he has in his power to prevent the formation of a urinary fistula.

URINARY FISTULÆ.—At present we have only to do with fistulæ of the urethra in men. These present a great number of varieties. Some authors have divided them into *congenital* and *acquired*. I have already said that *epispadia* and *hypospadia* ought not to be considered as urethral fistulæ, but rather as more or less complex vices of conformation of the urethra. We have seen, in studying these latter, that there are nevertheless some rare examples of *true congenital urethral fistulæ*, that is to say, fistulæ which are developed during intra-uterine life, and which follow a mechanism entirely comparable to that of fistulæ occurring after birth; they need not be again referred to.

Among non-congenital urethral fistulæ, a classification may be founded on the place at which the fistula opens, either into the rectum (*urethro-rectal fistula*), or on the surface of the skin (*urethro-cutaneous fistula*). The latter should be divided into two great classes, comprising: *urethro-perineo-scrotal fistula*, and *urethro-penile fistula*. This division is warranted by the notable differences which, from the standpoint of etiology, separate the two classes of fistula, but especially from the standpoint of their pathological anatomy and their prognosis I will, therefore, describe successively: (1) *urethro-rectal fistulæ;* (2) *urethro-perineo-scrotal fistulæ;* (3) *urethro-penile fistulæ.*

(1) *Urethro-rectal Fistulæ. Etiology.*—Much less frequent than other fistulæ of the urethra, urethro-rectal fistulæ may follow accidental operative wounds of the prostate, when, the limits of this gland having been passed by the cutting instrument, the latter opens at the same time both the urethra and the rectum. In lateral and pre-rectal lithotomy, an operative blunder may likewise be followed by the simultaneous opening of the urethra and the rectum. Foreign bodies introduced into the urethra (needles, pins, pipe-stems, pencils, ends of catheters) may perforate the urethro-rectal wall and become the starting point of a fistula. Conversely, vulnerating instruments or foreign bodies in the rectum, may produce the same result, acting from the rectum towards the urethra. Besides the different traumatic causes which have just been mentioned, there are a great number of pathological causes which may give rise to the production of urethro-rectal fistulæ, acting either from the urethra towards the rectum, or from the rectum towards the urethra. Thus abscesses of the prostate, either simple or tuberculous, perforating the recto-urethral septum, often become the source of persistent fistulæ; calculi arrested in the prostatic region of the urethra, or

developed in the substance of the prostate itself, may also cause perforation of the recto-urethral septum. On the other hand, but much more rarely, certain stercoraceous abscesses of hemorrhoidal origin, opening into the urethra, establish a permanent communication between this canal and the rectum. Finally, cancerous degeneration of the prostate or of the rectum sometimes leads to more or less extensive destruction of the recto-urethral septum, and is complicated with recto-urethral fistula.

Pathological Anatomy.—The urethral orifice of the urethro-rectal fistula is single, narrow, and most frequently situated in the prostatic portion, more rarely in the membranous portion of the urethra. In the first case it occupies one of the sides of the verumontanum. It is always higher than the rectal orifice. From this urethral orifice starts a sinus, which extends towards the rectum following an oblique direction, from above downwards and from before backwards, whence it results that urine flows easily into the rectum, whilst fecal matters, unless they are liquid, meet with some difficulty in ascending towards the urethra. It is not rare to see this sinus, which starts from the urethra, bifurcating—one branch of the bifurcation reaching the rectum, and the other opening upon the perineum ; in such a case the fistula is at once urethro-rectal and urethro-perineal.

The fistulous track is ordinarily sinuous, and sometimes so narrow as to permit only with difficulty the introduction of a probe. Its walls are indurated and callous, and give the sensation of a cord stretched from one orifice to the other. The rectal orifice is situated above the sphincter, and is often hidden among the folds of the mucous membrane. When it is exposed by means of a speculum, it presents itself under the appearance of a more or less narrow opening situated in the centre of a reddish fungosity. It is surrounded by callosities and nodosities, which are sometimes very hard. In some cases the fistulous opening on the side of the rectum is very large, and there is a true loss of substance in the recto-urethral septum. This state of affairs is met with especially in cases in which the prostate has been destroyed by extensive suppuration, by calculi, or by tuberculous or cancerous degeneration. The rectal mucous membrane, and the skin of the parts adjoining the anus, and that of the thighs, are often reddened, excoriated, and irritated by the continual contact of urine. Nevertheless, it should be noted that the inflammation of the rectal mucous membrane is much less intense than in cases of vesico-rectal fistula.

Symptomatology and Diagnosis.—The principal symptom of urethro-rectal fistula consists in the passage of urine by the rectum and of intestinal matters and gases by the urethra. The escape of urine by the rectum is not continuous, but takes place only at the time of micturition. If the opening is small and the urethra free, the quantity of urine which passes into the rectum is very trifling, and sometimes reduced to a few drops ; in the contrary case, the greater part of the urine escapes by the rectum. Although the urine usually flows by the anus at the very moment of micturition, and in the moments which follow it, cases have been seen in which the urine has accumulated in the rectum, and has been retained there for a greater or less length of time, as in vesico-rectal fistula. On the other hand, intestinal gases, and fecal matters, especially when they are liquid, escape by the urethra at the time of defecation. Sometimes solid fecal matters, or alimentary foreign bodies, become engaged in the urethra and are expelled by the meatus, after more or less violent efforts, accompanied by acute pains and even retention of urine. In some cases of very large fistula, the escape of spermatic fluid by the rectum has been observed at the moment of ejaculation. In a case reported in the thesis of Devin, on the other hand, the emission of spermatic fluid took place wholly by the urethra, which can be explained by the fact that the urethral orifice was behind the opening of the ejaculatory ducts.

These functional symptoms suffice to establish the diagnosis, which should be completed by a physical examination, for the purpose of determining exactly the situation of the orifices. Rectal touch will often suffice, in case of a large fistula, to lead to recognition of the rectal opening. If narrower, this is more difficult to recognize among the folds of mucous membrane, but it may often be suspected by the hard and irregular ridges which surround it. At any rate, it is always indispensable to expose it by means of an anal speculum, or better still, a Sims's speculum, the blade of which is applied against the posterior wall of the rectum. The opening is then sought for with a curved probe, which passes through the fistulous track and enters the urethra. If the precaution have been taken to introduce previously a metallic sound into the bladder, the point of meeting of the probe with the sound will determine exactly the seat of the urethral orifice.

The differential characteristics which distinguish vesico-rectal from urethro-rectal fistulæ, have been elsewhere considered, and I will merely say here that, in certain cases in which doubt is possible from the similarity of the functional disturbances, the diagnosis may be definitively established by the results furnished by injections of colored liquids forced into the bladder and into the rectum.

Prognosis.—Without speaking of the urethro-rectal fistulæ which complicate cancerous degenerations of the rectum or prostate, and the cure of which is impossible, it may be said that the prognosis of urethro-rectal fistula is graver in proportion as the disorder is older and the fistula is larger. Account must be taken likewise, in the prognosis, of the cause which has given rise to the fistula. Thus whilst traumatic fistulæ, those which follow acute and tolerably circumscribed abscesses, present a good prospect of recovery, fistulæ which follow in the train of diffuse and extensive suppuration, either idiopathic or of a tuberculous nature, and which are accompanied by prostatic sinuses, are almost always incurable. Finally, if there be some examples of spontaneous recovery of urethro-rectal fistulæ, it must be acknowledged that most frequently they last indefinitely, and we shall soon see that the chances of cure by surgical interference are extremely few.

The persistence of urethro-rectal fistulæ may become the starting point of more or less serious conditions which may even lead to death. These conditions, resulting from irritation of the rectal mucous membrane on the one hand, and of the urinary mucous membrane on the other, are manifested by the habitual symptoms of recto-colitis and urethro-cystitis, and may reduce the patient to the last degree of marasmus. Nevertheless, these conditions are generally less frequent and less grave in urethro-rectal fistulæ than in vesico-rectal fistulæ, and from this point of view the prognosis of the former is less serious than that of the latter.

Treatment.—To obtain the cure of a urethro-rectal fistula, three indications ought to be fulfilled: 1. To restore the permeability of the urethra, if there be occasion; 2. to protect the fistula from contact with urine, fecal matters, and intestinal gases; 3. to act directly on the orifices and on the fistulous track, to provoke their obliteration.

1. If the urethra be the seat of a stricture, the permeability of the canal ought to be at once re-established by the means which are customarily employed in such cases, and which it is useless to recapitulate here.

2. If the channel of the urethra be free, to fulfil the second indication a catheter should be retained, or the patient should be catheterized as often as may be necessary, in order to prevent the contact of urine with the fistula. It is less easy to prevent the passage of fecal matters and intestinal gases.

Besides the need of checking diarrhœa, when it is present, by every possible means, it is necessary to regulate the stools, by having an emollient enema administered every day. The introduction into the rectum of pieces of rag, of an œsophageal tube open at both ends, of a silver canula furnished with an apron, may up to a certain point prevent the adverse action of intestinal gases and solids, by closing the fistulous orifice in the intervals of defecation, and even by exercising a moderate compression on the fistulous track.

3. In some cases, these simple measures suffice to bring about the cure of the fistula. But much oftener they remain inefficacious, and under such circumstances it is necessary for the surgeon to act directly upon the fistulous orifice and track. Recourse may be had at first to repeated cauterizations of the rectal orifice, and even of the track, either with different solid or liquid caustics, or with the galvanic or thermic cautery. This method, which has succeeded sometimes in cases of narrow fistula, also fails very often, and is not suitable for fistulæ with very large orifices. In such cases recourse must be had to the knife. Unfortunately, the various attempts which have been made in this direction have furnished more reverses than successes, which is explained, on the one hand, by the difficulties which are met with in the very execution of the operation, and on the other hand by the injurious influence of urine, and of fecal matters and gases, on the parts which have been freshened and united by sutures, hindering or destroying the work of cicatrization.

The operative method most generally followed sensibly approaches the method of treatment of vesico-vaginal fistulæ, called the "*American method.*" It consists in vivifying the circumference of the rectal opening, previously exposed with a Sims's speculum, over a very extended surface, and in then suturing the parts with silver wire.

In a case of extremely large fistula, which had resisted suturing in the ordinary way, I had recourse to the following procedure, which gave me a good result: I cut a large mucous flap on one side of the rectum, which I dissected off and left adherent at one edge of the fistula; it was then turned over and sutured by its free edge to the previously vivified semi-circumference of the fistula. A complete account of this interesting case, and a description of the operative procedure, have been given by Devin.

The numerous failures of autoplastic methods have led some surgeons to propose other operations, more or less grave, with the object of effecting the cure of urethro-rectal fistulæ. Thus Sir Astley Cooper carried out the following procedure: A catheter having been introduced into the bladder, he made an incision on the left side of the raphe, just like that for lithotomy, until he felt the staff through the bulbous portion of the urethra. Then he plunged a double edged knife into the perineum, between the prostate and the rectum, so as to lay open the fistulous communication which had been established between the urethra and the intestine. A pledget of charpie was introduced into the wound. Afterwards the urine flowed by the perineal wound, the fistulous opening in the rectum gradually closed, that in the perineum promptly cicatrized, and the urine resumed its normal course.

Desault proceeded in a different manner, opening a free passage for the intestinal matters by division of the external sphincter and of the rectum up to the fistulous orifice.

Finally, when there is in the perineum a fistula which opens at the same time into the urethra and the rectum, the perineal sinus might be made use of to incise, upon a grooved director, as in the operation for anal fistula, the whole thickness of the tissues between the opening and the bowel. The intestinal matters, escaping easily by this large opening, would no longer have a tendency to flow back toward the urethral orifice, which after that could cicatrize.

It need not be mentioned that these different operations, as well as the plastic methods above mentioned, would be altogether contra-indicated in cases of urethro-rectal fistulæ symptomatic of organic diseases of the rectum or prostate.

(2) *Urethro-perineo-scrotal Fistulæ. Etiology.*—Urethro-perineal and urethro-scrotal fistulæ are of all urethral fistulæ the most common. Their causes are very numerous. Contrary to what we shall find in regard to urethro-penile fistulæ, these rarely follow wounds of the perineal or scrotal region, at least when the wounds are clean cut, and not complicated with infiltration of urine. Under opposite circumstances, in consequence of urinary phlegmons of the perineum and scrotum, caused by wounds of the urethra, one or more fistulæ may be seen to persist. Whilst the various operations of perineal lithotomy, the perineal *boutonnière*, and external urethrotomy, are rarely followed by fistulæ, traumatic ruptures and lacerations of the urethra by contusion of the perineum, causing vast abscesses or very extensive urinary infiltrations, are, on the other hand, often thus complicated.

We have just seen that, even in cases in which urethro-perineo-scrotal fistulæ have a traumatic cause, inflammation, suppuration, and urinary infiltration play the most important part in establishing the fistulous track. It is conceivable from this, that inflammations or infiltrations of urine developed without any traumatic cause may produce the same results. Simple or virulent urethritis, by provoking the formation of glandular or peri-urethral abscesses, opening at the same time into the urethra and on the exterior, has, in certain rare cases it is true, determined a urinary fistula.

Ulceration of the urethra by a calculus or by a catheter, may end by completely perforating the canal, and may thus cause a urinary abscess or an infiltration of urine, which in turn will give rise to one or several fistulæ. But one of the most frequent causes of perineo-scrotal fistula resides in the presence of an inflammatory or traumatic stricture. We have already studied the different secondary lesions which are produced behind the coarctation of the urethra, and which result in the formation of urinary abscesses, of urinary pouches, of infiltrations of urine, and which sometimes even cause sudden and more or less complete rupture of the canal at the moment of an effort at micturition. It is these different anatomical alterations which prepare for the formation of fistulæ, consecutive to strictures.

Although the urinary fistulæ which we are studying may be established under the exclusive influence of the different causes just enumerated, and in subjects apparently in very good health, it should be admitted, with Cocteau, that a bad constitution—a general weakening produced by constitutional diseases, such as phthisis—may favor in a certain measure the development of fistulæ.

Finally, it is found that urethro-perineo-scrotal fistulæ are often multiple. In a certain number of cases these multiple tracks are established at once, as when, for example, there are fistulæ consecutive to an extensive urinary infiltration, this having given rise to a number of openings which have continued to give exit to urine. In other circumstances fistulæ may be multiplied in the following manner: The more or less long, sinuous, anfractuous track retains at each micturition a small quantity of urine, which inflames the tissues and sets up small abscesses, followed by burrowing, and finally by secondary sinuses, which soon open upon the skin and constitute new fistulæ. It may also happen that the cutaneous orifice of a fistula, more contractile than the deep orifice and the walls of the sinus, is momentarily contracted or even obliterated; whence arise retention of pus and urine in the cavity, and the formation of abscesses and sinuses which open in the perineum or in the scrotum.

Pathological Anatomy.—The internal orifice of the fistula is often single, of variable dimensions—sometimes broad and funnel-shaped—especially when there has been a loss of substance. In other cases there are found, in the membranous and prostatic regions, a number of small openings or even a crowd of side channels, uniting in a single sinus at a small distance from the canal. Sometimes these side channels open in a urinary pouch, or in a urinary abscess, from which one or a number of sinuses are given off.

In the immense majority of cases there are a number of cutaneous orifices. Civiale counted as many as fifty-two in the same subject. I have already indicated the mode of formation of multiple orifices. They open in the perineum, upon the scrotum, at the level of the root of the penis, without it being possible to assign to them any seat of predilection. But often, on account of the considerable extent of the burrowing and infiltration of urine, these perineo-scrotal fistulæ are accompanied by secondary sinuses opening in the groin, at the upper part of the thigh, or even in the neighborhood of the knee. In other cases the secondary orifices are seen on the buttock (the infiltration of urine being propagated through the greater sciatic notch), in the lumbar region, or in the hypogastric region. Each cutaneous orifice presents itself usually under the appearance of a red vegetation, rounded, more or less hard, like a hen's anus; sometimes the orifice is concealed under a fold or puckering of the skin. Sometimes the multiple orifices are separated by portions of healthy integument, sometimes they are united in a limited space, looking like a fungous and vegetating mass. The dimensions of these orifices are variable; sometimes so narrow as hardly to admit the smallest probe, sometimes large enough to permit the passage of an ordinary bougie.

The arrangement of the fistulous track presents some differences with which it is important, for therapeutic purposes, to be acquainted. Its length varies from three or four to eight or ten centimetres. It is more or less straight; in the great majority of cases it is irregular—tortuous, anfractuous, presenting prolongations ending in *culs-de-sac*, or opening into cavities in which pus and urine stagnate. The walls are lined with a smooth membrane, which is very adherent to the subjacent tissues, presents the appearance of mucous membrane, and secretes a small quantity of muco-pus. When the track is long and sinuous, its walls are soft and fungous, and furnish a more abundant puriform secretion.

Perineo-scrotal fistulæ are not long in being complicated with secondary lesions, the most frequent of which consists in induration of the soft parts which surround the fistulous tracks, an induration which results from chronic inflammation of those parts under the influence of the continual action of urine. This induration, limited at first to the walls of the fistulous tracks themselves, is made manifest by the presence of a ligamentous cord, which may be felt with the fingers, and which extends from the external orifice towards the urethra. Afterwards this induration extends to the cellular tissue of the scrotum and of the perineum, and forms inequalities, larger or smaller elevations, which are sometimes so developed that they completely change the appearance of the parts; thus the scrotum may be trebled in size, and the penis may disappear in the midst of this enormous tumor. Although the tumefaction and induration of the parts are generally diffuse and not well limited, there have sometimes been seen to develop in the neighborhood of the fistulous tracks true isolated tumors, and in one case Voillemier[1] found it necessary to practise ablation of one of these tumors, which consisted of a hypertrophy of the connective tissue and of the muscular tissue (fibrous myoma). In diffuse induration the tissues are white and but slightly vascular; they creak under the knife, and sometimes undergo cartilaginous or osseous degeneration.

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[1] Cocteau, Thèse, p. 37.

These profound alterations of the soft parts which surround perineo-scrotal fistulæ are of importance, and they explain how fistulous tracks may persist without any tendency to obliteration, even when the calibre of the urethra is entirely re-established, and when the urine flows freely by the natural channel. It is necessary, in such cases, to act directly upon the indurated and callous tracks in order to bring about their cicatrization.

Perineo-scrotal urinary fistulæ may be complicated by the presence of foreign bodies (fragments of catheters, balls, sequestra), and of calculi.

These calculi, to which Louis[1] has drawn attention, may be formed slowly by successive deposits of the salts contained in the urine; but the tendency at the present day is to consider them as calculi of the bladder or prostate, caught in the sinuosities of the fistula, outside of which they have had their birth. It will be understood, however, that these calculi may increase little by little in size by the addition of new layers, following the mode of increase of calculi caught in the urethra. In some cases, instead of real calculi, a sort of incrustation is seen, or calcareous infiltration of the walls of the fistula. It is not rare indeed to find this same calcareous incrustation of the portion of the urethra situated behind the internal orifice of the fistula, the incrustation being prolonged as far as the neck of the bladder.

Symptomatology and Diagnosis.—The escape of urine during micturition is the characteristic symptom of the fistulæ which we are studying. This discharge presents notable differences, in accordance with the degree of permeability of the urethra and the different anatomical conditions of the fistula: sometimes not a single drop flows from the meatus, and the patient urinates exclusively by the fistula; sometimes part of the urine flows by the penis and part by the fistula, and there are a large number of varieties in this respect; sometimes the fistula gives exit to only a few drops which escape at the end of micturition. Finally, there are cases in which, the small quantity of urine which penetrates the fistulous track mixing with the muco-pus secreted by the latter, and escaping outside some time after micturition, it becomes difficult to decide at first whether or not the fistula communicates with the urethra. In such a case, one may be put on the track of the diagnosis by the urinous odor of the secretion, and recourse may be had to the method proposed by Dieffenbach, and which consists in compressing the glans at the moment of micturition in such a manner as to force the urine to flow back through the fistula. In the intervals of micturition the fistula gives exit to a muco-purulent liquid, the quantity of which is dependent upon the extent and number of the tracks, the presence of diverticula, and the existence of inflammatory complications. The spermatic fluid follows the same course as the urine; sometimes escaping entirely by the fistula, sometimes, and oftener, passing partly by the urethra and partly by the abnormal opening.

I have already described the appearance of the external opening or openings of the fistula; I shall add that usually the skin of the regions bordering upon this opening is more or less red, inflamed, and excoriated by the contact of urine and pus. As I have pointed out, it is often possible to feel the hard and resistant fibrous cord which starts from the fistula and goes towards the urethra. It is especially in fistulæ exempt from complications, and situated in the scrotum, that this fibrous cord is easily perceptible.

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[1] Mémoire sur les pierres urinaires formées hors des voies naturelles. Mem. de l'Acad. Roy. de Chirurgie, t. ii. p. 319.

Although in the immense majority of cases the diagnosis of perineo-scrotal urethral fistula may be established from the nature of the functional troubles, and after a simple external exploration, it is necessary, either to complete the diagnosis or to throw light upon obscure cases, to have recourse to catheterization of the fistula, combined with that of the urethra. A flexible probe is introduced into the sinus, at the same time that a metallic sound is placed in the urethra. It is always necessary to proceed with great gentleness in the catheterization of the sinus. This mode of exploration usually makes it possible to discover the direct communication between the urethra and the fistulous track, and furnishes valuable information in regard to the direction, the length, and the dimensions of the track, and the existence of diverticula or foreign bodies. Nevertheless, it must be said that in a certain number of cases, by reason of the tortuosity of the fistulous canal, it is not possible to pass through its whole length, and to succeed in touching the sound introduced into the urethra. If, in such a case, the communication remained uncertain, and was not sufficiently established by the nature of the functional disturbances, recourse could be had to injections practised with colored liquids, either into the urethra, or, better, into the fistulous track; the return of the liquid by the fistula or by the urethra would remove all doubt.

After what I have just said, I will not dwell upon the differential diagnosis of perineo-scrotal urethral fistulæ, which could only be confounded with vesico-perineal fistulæ or with rectal fistulæ, or with sinuses dependent on caries or necrosis of the bones of the pelvis. The manner of escape of the urine makes it possible to make a diagnosis between urethro-perineal fistulæ and vesico-perineal fistulæ; it is intermittent in the first case and continuous in the second. As to the differential diagnosis between urethral fistulæ and rectal fistulæ or bone-sinuses, it can in general be easily arrived at by studying the history of the case and the nature of the liquids which flow from the cutaneous orifices, and finally by direct exploration.

Prognosis.—In the prognosis of urethro-perineo-scrotal fistula, it is necessary to take into account the fistula itself, and the cause which has produced it. Now, usually the fistula aggravates the already serious prognosis of the initial disease, which is most commonly a stricture, and this aggravation is a result of the formation of new abscesses in the scrotum and perineum, of the possible appearance of urinary infiltration, of erythema of the skin which surrounds the fistula, and finally of the numberless annoyances which are brought about by the escape exteriorly of pus and urine which soil the clothing of the patient.

From another point of view, although perineo-scrotal urethral fistulæ, free from complications, are generally easier to cure than urethro-penile fistulæ, nevertheless this relatively favorable prognosis is far from being applicable to all cases, and in practice there are seen a large number of complicated perineo-scrotal urethral fistulæ the cure of which is very difficult to obtain, and the treatment of which demands grave operations.

Treatment.—A certain number of perineo-scrotal urethral fistulæ heal spontaneously, as soon as it is possible to effect the disappearance of the causes which have given rise to them; others require the employment of special measures directed against the fistulæ themselves. It may be said, then, that the first indication in the treatment of these fistulæ, consists in restoring to the urethral canal its calibre, its suppleness, its normal qualities. Then, as strictures are the usual cause of these fistulæ, it is against them that therapeutic measures should at first be directed. In the absence of any special indication, the surgeon should always begin with either temporary or permanent dilatation; then, when the calibre of the urethra is re-established, contact of urine with the fistula is to be prevented either by catheterization, repeated as often as may be necessary, or by more or less prolonged employment of a retained catheter, and by this very simple method a certain number of urethro-perineo-scrotal fistulæ can be cured. In regard to the use of the retained catheter after preliminary dilatation of the urethra, I will further insist upon an important therapeutic detail which has also an applicability to other methods of treatment. It often happens that, after having kept a catheter in the bladder for quite a long time without succeeding in obtaining the occlusion of the fistula, if the instrument be removed, healing will take place in a few days. This fact should always be present to the mind of the surgeon, and he should remember that the use of the catheter ought not to be continued indefinitely, and that it may be useful to lay it aside from time to time.

But it too often happens that dilatation, followed by the use of the retained catheter, is powerless to cure perineo-scrotal fistulæ of the urethra. One may then have recourse to internal urethrotomy, or to external urethrotomy with or without a guide. Without dwelling on the indications proper to these two methods of treatment of stricture of the urethra, I will nevertheless say, that, in the cases now under consideration, external urethrotomy presents in a very large number of instances a manifest superiority, and that sometimes it even constitutes the only operative method. Thus, when perineo-scrotal fistulæ are accompanied with impassable strictures, external urethrotomy alone is applicable; it is also best suited for traumatic strictures which, although passable, are very close, very tough, and very little dilatable, and especially when the fistulæ are numerous, sinuous, complicated with diverticula, and with extensive indurations of the tissues of the perineum and scrotum.

As to the therapeutic measures applicable to the fistulæ themselves, they consist in the use of injections, cauterizations, and incisions. These different measures, as will be understood, are especially suited to cases in which dilatation or internal urethrotomy has been practised, for if recourse has been had to external urethrotomy, the free incision of the perineum usually suffices to divide the different tracks or diverticula, and to secure complete cure. Injections introduced either by the urethra, or by the fistulous orifices, and made either with a phenic acid solution or with a weak solution of nitrate of silver or of tincture of iodine, have sometimes contributed to cleanse the fistulous tracks and to bring about their cicatrization; but this is a method generally not very efficacious. It is not the same with regard to more energetic cauterizations, either with the nitrate of silver, or better with the red-hot iron, according to the method recommended by Bonnet, of Lyons. This latter method is, however, associated with that of incisions, formerly much esteemed, and which consists in slitting-up with a bistoury the sinuses and the diverticula to the urethra. Some surgeons have even advised excising the indurated tissues around the fistulæ. In our days, thanks to the thermo-cautery, it is easy to combine incision with cauterization, and in the case of very complicated fistulæ this method of treatment is likely to be followed by success, on condition, let it be understood, that the calibre of the urethra has been re-established, either by dilatation or by internal or external urethrotomy, and that a catheter has been left in.

As to autoplastic operations, they are very rarely applicable to perineo-scrotal fistulæ of the urethra.

(3) *Urethro-penile Fistulæ. Etiology.*—The majority of the causes which I have already enumerated in speaking of the different varieties of urinary fistula,

may act in the production of urethro-penile fistulæ. I will not return to them then, but I will confine myself to mentioning the most frequent causes of these latter fistulæ.

Among these causes we must place in the first rank traumatisms: simple or contused wounds, and especially wounds with loss of substance, such as those which are produced by projectiles of war. In connection with these should be noted a variety of traumatism altogether peculiar to this region, I mean constriction of the penis by an encircling band, such as is sometimes seen in infants. In these cases the urethra may be opened, or even completely divided, after the fall of the eschar.

Urethro-penile fistulæ may also be the consequence of strictures of the urethra, and may be produced according to the mechanism already described. Finally, more frequently than in the case of other fistulæ, there have been noted as the origin of urethro-penile fistulæ peri-urethral abscesses, suppurative inflammations of the glands of the urethra, and chancres, especially phagedenic chancres; all causes which act by determining perforation of the canal from without inwards.

Pathological Anatomy.—Urethro-penile fistulæ present, because of the region which they occupy, quite peculiar anatomical characteristics. The fistulous track is always straight and very short, rarely exceeding a centimetre; sometimes it even seems not to exist, the two orifices being almost blended in one, and the skin and mucous membrane being almost immediately continuous one with the other, in consequence of the thinness and atrophy of the spongy body in the neighborhood of the urethra. Contrary to what is so frequently observed in perineo-scrotal fistulæ, urethro-penile fistulæ are exempt from prolongations and diverticula, and the sinuses are single; sometimes perpendicular to the axis of the canal, the fistulous track is usually oblique from behind forwards, so that the external is nearer to the glans than the internal orifice. The single internal orifice has a construction peculiar to these fistulæ: it has the shape of a funnel, quite broad on the side of the canal, and growing narrower to become continuous with the sinus. The external orifice is lined with a shining, smooth, thin membrane, very adherent to the subjacent tissues, and generally destitute of granulations. Although the orifice is usually single, there have been seen sometimes, especially at the level of the glans and more especially of the fossa navicularis, extremely small, multiple orifices. In a case of obliteration of the meatus urinarius, Lallemand[1] observed the presence of a large number of small fistulæ at the level of the glans, which resembled the spout of a watering-pot. The cutaneous orifice is sometimes buried, depressed, concealed under a fold of skin, and hard to discover. Finally, the indurations and callosities which are so frequent in fistulæ of the perineum and scrotum, are not generally met with about the external orifices of urethro-penile fistulæ. In fistulæ with considerable loss of substance, the skin adheres intimately to the walls of the urethra, and is, so to speak, continuous with the mucous membrane.

The dimensions and forms of these fistulæ are very variable: sometimes they are very fine channels hardly admitting a bristle; sometimes they reach a diameter of a centimetre or a centimetre and a half, or more. Whilst some are, so to speak, destitute of an intermediate sinus, some have been seen in which this measured two or three centimetres in length, or even reached six centimetres, as in an example cited by Jobert.[2]

Symptomatology and Diagnosis.—Independent of the external characteristics of the fistulous opening which have been already described, the symptoms of urethro-penile fistulæ are limited to disturbances occurring in micturition and in ejaculation. The urine flows at each micturition either altogether or in part by the fistula; similarly, the spermatic fluid may escape by the abnormal channel in variable quantity. Thus the diagnosis of these fistulæ is generally extremely easy. Nevertheless, in some cases of very narrow fistula, barely permitting the escape of a slight leaking of urine, doubt may be possible; in such a case the escape of urine ought to be provoked by compressing the glans at the moment of micturition, and by surrounding the penis at the level of the supposed orifice of the fistula with a fine and well-dried piece of linen so as to collect the smallest quantity of urine. Finally, as in the case of perineo-scrotal urethral fistulæ, it may be useful to complete the diagnosis of urethro-penile fistulæ by determining exactly their form, their extent, and their direction, which can be easily done by exploring the fistula while a sound is in the urethra.

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[1] Bermond, Considérations pratiques sur les rétrecissements. Gaz. Méd. p. 158. 1838.

[2] Traité de Chirurgie Plastique, t. ii. p. 164.

Prognosis.—Less serious than other urethral fistulæ, in the sense that they are usually exempt from complications and less frequently accompanied by secondary alterations in the bladder and kidneys, urethro-penile fistulæ none the less offer a serious prognosis, because of the sometimes insurmountable difficulty which is encountered in curing them. Although in a general way large fistulæ are harder to cure than narrow fistulæ, nevertheless very small fistulæ are often seen to resist every method of treatment, and to be obliterated only after long and patient efforts.

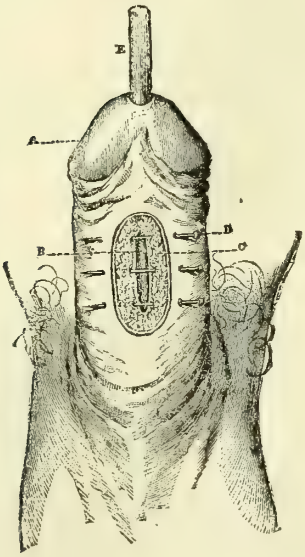
Treatment.—As for other fistulæ, the first indication consists in restoring to the urethra its normal calibre. This first point secured, the fistula itself is to be attacked, and the numerous operative procedures which have been devised with the object of closing the accidental opening, bear witness to the difficulties which are met with in practice, and which I have referred to in connection with the prognosis of urethro-penile fistulæ. The retention of a catheter and the intermittent use of bougies, which sometimes suffice to bring about the cure of other urethral fistulæ, remain powerless in the treatment of urethro-penile fistulæ, but they constitute very useful, and even indispensable, adjuvant measures after operations practised upon the fistula. These operations are very numerous, and I shall refer the reader, for their detailed description, to special treatises on the diseases of the urinary passages. There have been employed for urethro-penile fistulæ: 1, *cauterization;* 2, *urethrorraphy;* 3, *urethroplasty.*

1. *Cauterization.*—This method is hardly ever suitable, except for fistulæ of small dimensions. It is practised with either solid or liquid caustics, or with the hot iron. As it is an innocent method, and easy of application, it may be well to employ it at first in the treatment of narrow fistulæ, giving the preference to the hot iron. Although cauterization fails very often, it has, nevertheless, furnished a certain number of successes. One ought not to persist too long in the employment of this method, for fear of increasing the size of the fistula.

2. *Urethrorraphy.*—Various methods of urethrorraphy have been devised. I will describe that which appears to me much superior to all the others, and which is almost analogous to the procedures employed by Voillemier and Verneuil. In this method (Fig. 1353), instead of freshening the edges of the fistula themselves, the freshening should be carried out upon the skin and the subcutaneous tissues which surround the fistulous orifice for a distance of half a centimetre, so as to bring together surfaces and not edges. As to the suture, one may use either the twisted suture, like Voillemier, or the interrupted metallic suture, like Verneuil, taking care that the pins or the wires pass obliquely through the whole thickness of the lips of the incision wound, but without involving the mucous membrane. Although the apposi-

tion of the surfaces may be very satisfactory by one or other of these methods of suture, it is made more perfect still by the employment of the shotted suture with a single wire, analogous to that which I have recommended in the treatment of hypospadia.[1] Urethrorraphy, practised according to the preceding principles, very often gives excellent results; nevertheless, in some cases of extensive loss of substance, it proves inefficacious, and recourse should then be had to urethroplasty.

Fig. 1353.



Urethrorraphy, by Voillemier's method.

3. *Urethroplasty.*—Here the methods are extremely numerous, and I shall limit myself to indicating the principal ones, referring the reader to special works, and to the Thesis of Cocteau, who has presented a complete study of these procedures. According to this last author, these operations may be arranged in two great classes, according as they belong to the *Indian method* or to the *French method.*

The *procedures of the Indian method* consist in taking a flap from a neighboring region and turning it over so that its bleeding surface may be in contact with the edges of the fistula, previously freshened. The flap has been taken either from the scrotum (Sir Astley Cooper), from the inguinal region (Delpech), or, finally, from the crural or from the abdominal region (Jobert). These more or less complicated operations have furnished only indifferent results.

The *procedures of the French method* form two classes, according as the flaps, transferred by sliding, are united by their edges or brought into apposition by surfaces. The procedures which belong to the first class consist either in dissecting up the skin which surrounds the fistula, and drawing it up until it covers the latter, or in cutting lateral or anterior and posterior flaps, which are left adherent by their extremities, and which are loosened at the part which corresponds to the fistula, so as to bring them together by sliding and to unite them edge to edge in front of the abnormal opening. All these methods are inferior to those of the second class. Among the latter, the simplest are the methods of Delpech, in which a flap, taken either from before or behind the fistula and brought over it by sliding, is applied against a freshened surface, previously prepared either in front of or behind the abnormal opening.

Other and more complicated procedures are those which have been designated by the name of "*doubling methods*," or methods "*by a double flap.*" Among these are the methods of Artaud, of Rigaud, and of Sédillot. They all consist in cutting a penile flap and a scrotal flap, which reciprocally cover each other, and fully obliterate the fistula.

Let me cite still the method of Nélaton, by *splitting and apposition of surfaces.* In this method (Fig. 1354) the edges of the fistula are freshened, *B*, transverse incisions are made, *C D*, involving the skin and the subcutaneous tissue of the penis beyond the superior and inferior limits of the perforation, and to a distance of about two centimetres. The flaps are dissected from each side by passing a blunt-pointed bistoury, *F*, under the skin, which is loosened all around the fistula. When this manœuvre is executed, there is a considerable extent of skin, having at the centre the cutaneous orifice, and at each extremity two bridges limited on one side by the fistula, and at the other by the transverse incisions. These integuments are brought together by bringing the freshened surfaces into contact, and fixing them by the twisted or the shotted suture.

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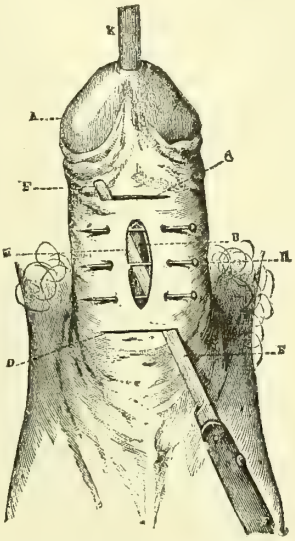
[1] See Figures 1345 and 1346, p. 495, *supra.*

I shall pass over in silence a certain number of methods, designed for special cases, and which might accidentally be applicable. I think, moreover, that in the immense majority of cases, when urethrorraphy has failed, preference should be given to a method of urethroplasty exactly analogous to that which I have applied to the restoration of the urethra in hypospadia—a method which much resembles that which Reybard has described, and which consists in cutting from each side of the fistulous opening two small flaps, sufficient to cover the former by their reversal inwards, and then in separating the skin of the penis on the sides, so as to cover in the preceding flaps. As to suture, I recommend especially the shotted suture with a single wire, which I have already described.

Fig. 1354.



Nélaton's method of urethroplasty.

Finally, when the various methods which I have just described have failed—since one of the most active causes of failure resides in the contact of urine, which, in many cases, neither the employment of the retained catheter nor intermittent catheterization succeeds in preventing—recourse may be had to a practice first recommended by Louis, and then by Viguerie, Dieffenbach, and especially Ségalas, a practice which consists in making a perineal incision with the object of turning aside the current of urine while cicatrization of the fistula takes place.

It is for the same purpose that some surgeons have advised to dilate a concomitant perineal or scrotal fistula, and that Malgaigne proposed puncturing the bladder with a canula, which was to be allowed to remain.

These various operations evidently should not be made a general method of treatment, but they constitute very useful adjuvant measures, to which it may be proper to have recourse in certain especially rebellious cases.

Urinary Fever.—Under the names of *urinary*, *urethral*, *urethro-vesical*, and *uræmic fever*, and of *urinary intoxication*, *resorption*, and *poisoning*, are designated febrile accidents of variable form and intensity, which may occur in the course of diseases of the urinary passages, sometimes without apparent cause, but more frequently after operations even of the most simple character, such as sounding.

Velpeau, in 1833, and almost at the same time Civiale, pointed out for the first time the most startling of these accidents; they brought to notice the pathological bond which unites to affections of the urinary passages the phenomena of urinary fever, until then unknown in their essence, or misinterpreted. Since then this affection has been the object of numerous studies, to the more important of which I shall refer when, after having described the clinical forms of urinary fever, I shall attempt to elucidate its pathogeny, which is still obscure in a certain number of points.

Symptomatology.—The symptomatic aspect in which urinary fever presents itself is extremely varied, and the multiplicity of shapes which the affection may assume is one of the difficulties of its clinical study. Urinary fever is not a unit; it affects multiple clinical forms. Sometimes it shows itself by striking phenomena, breaking out suddenly, and generally of short duration: this is the *acute form.* Sometimes it takes a less active course, and then proceeds slowly, with less violent manifestations, sometimes even hardly appreciable: this is *the chronic or slow form.* But, again, in each of these two forms it is necessary to recognize different types, according to the appearance which the disease assumes. Thus the acute form of urinary fever includes three types: (1) Type with frank paroxysms; (2) Type with pernicious paroxysms; (3) Continuous-remittent type. The *chronic or slow form* is characterized by a febrile state, which is not very intense, but permanent, and with slight variations in the degree of the fever; it occurs as a primary affection, or follows the acute form. The two varieties, acute and chronic, may coincide in a single patient, and nothing is less rare than to see acute phenomena break out in a patient who for a longer or shorter time has shown symptoms of the chronic form. It is likewise common to both forms to have phlegmons in peculiar situations, which frequently end in suppuration.

Acute Form of Urinary Fever.—(1) *Fever with frank paroxysms.*—In this first type, urinary fever reveals itself suddenly by a febrile attack, a complete and well-marked paroxysm comprising the three classic stages: chill, fever, and sweating. Excited usually by a catheterization or by an operative procedure, or even appearing spontaneously in an individual who has an affection of the urinary passages, the frank attack always begins with a chill. The length and intensity of this chill are variable. It may last from some minutes to two or three hours; usually its duration varies between half an hour and three-quarters of an hour. Its intensity is almost always considerable: simple sensations of cold are rare; ordinarily there are general trembling and chattering of the teeth. In exceptional cases cyanosis, coldness of the extremities, and extreme anxiety, may be observed. The stage of chill is immediately followed by a more or less well-marked stage of heat. In ordinary cases the eyes are brilliant, the skin dry and burning; the respiration, which is less anxious and fuller than in the preceding stage, is still hurried. All these phenomena diminish gradually. The skin, moist at first, is soon soaked with an abundant perspiration, which covers the entire body and may inundate the bed. This is the stage of sweating, which always terminates a frank attack. The patient, having become calm, says that he feels well. The attack is ended, leaving behind it only a little fatigue, which disappears after two or three days. From the outset of the urinary attack the thermometer mounts suddenly from 37° to 40° C. (98.6° to 104° F.), and even 41° C. (105.8° F.); when the attack is ended it sinks rapidly by a frank defervescence, and redescends, in twenty-four hours at most, sometimes in a few hours, to 37° C. However, even in this frank attack, things do not always pass so simply: there are certain complications which supervene, and which give the frank attack a special physiognomy, that it is important to be acquainted with in order not to go astray.

It is proper to place in the first rank *nervous disturbances*, usually manifesting themselves in the form of delirium: this delirium, sometimes wandering (sub-delirium), sometimes violent, usually begins during the stage of chill, but its appearance may be delayed till the stage of fever. It is without great prognostic importance. The frank attack of urinary fever is always accompanied *by digestive disturbances:* the tongue is broad, and covered with a thick, furry coat; the mouth is sticky and bitter; there are nausea and almost always one or two vomitings of food or glairy matter, with a little diarrhœa. Sometimes these symptoms are exaggerated. The tongue becomes more or less dry, the saliva is acid, and explains the frequent occurrence of thrush in the subjects of urinary disorders; the vomiting is repeated; the stools become very abundant and fetid; there is a veritable gastro-intestinal crisis. The oppression, which constitutes a part of the attack, goes on in some cases to an intense *dyspnœa:* the patient complains of a sensation of weight upon the sternum, which prevents him from expanding his thorax; nevertheless, nothing is discovered upon auscultation. Finally, complications may arise in connection with the *circulatory system:* the pulse, always accelerated during the progress of the attack, small at the beginning, full and strong at the end, very frequently has irregularities and intermittencies. These phenomena, which begin with the attack or a little before, usually cease with it, but may persist for several days. They are not connected with cardiac alterations, for auscultation reveals no abnormal sound; they appear to me to be attributable to troubles of the capillary circulation, under the influence of the badly depurated blood which these vessels convey at the times of the attacks. It may be, also, that this blood acts upon the medullary centres, and especially upon those of the pneumogastric: the respiration, indeed, is likewise altered in its rhythm, but the ear detects no abnormal sound, either in the lungs or in the heart.

(2) *Fever with pernicious paroxysms.*—In this second type, urinary fever proceeds also by paroxysms, but these attacks present this peculiarity: that one of their symptoms, or one of their stages, is much exaggerated and dominates the scene: the proportion between the different stages of the frank attack is broken in favor of one of them. According to the predominant phenomena, there may be observed: (*a*) A fever with pernicious paroxysms of *indeterminate form*, in which are found the three stages of the frank attack, but in which the fever, which is more intense, has begun with a more violent and longer rigor; a stage of very high fever is succeeded by abundant sweats, and the patient, worn out, having no more strength to react, succumbs in from twenty-four to thirty-six hours; (*b*) A fever with pernicious attacks of an *algid type*, remarkable by the intensity and the duration of the chill or chills with which it begins, and by the exaggeration of the ordinary symptoms of the first stage—agitation, anxiety, cyanosis, coldness of the extremities; reaction does not take place, and the patient succumbs; (*c*) An *asphyxic* form, characterized by suffocation occurring in the midst of the stage of heat; and (*d*) other forms, still—*typhous*, *tetanic*, *choleriform*, etc.—but much less clearly defined.

(3) *Remittent-continuous fever.*—This third type of acute urinary fever is characterized by repeated paroxysms of a form varying according to the individuals, but repeating themselves almost always in the same form in the same patient; a more or less marked, continuous febrile state fills up the intervals of the exacerbations. After a violent and long chill, the hot stage which always follows it in frank attacks is not seen to come on; reaction takes place slowly and imperfectly; the patient appears to have difficulty in coming out of his febrile state, and, in fact, he does not come out of it; when finally he is warmed up again, he is burning and agitated, for it is unusual to see, on even a few points of the body, a partial perspiration, instead of the abundant sweats which terminate the frank attack. The length of this attack is notably longer than that of the frank attack. The thermometer oscillates between 40° and 41° C. (104° and 105.8° F.)—once Guyon saw it at 41.6° C. (106.9° F.), in a patient on whom he had performed lithotrity; it does not, however, rise higher than in the frank attacks, but it does not fall

to the normal point; and the tracing taken in these cases shows a series of summits which separate more or less deep depressions. Complete apyrexia is very rare in this form of the affection.

The complications of this third type are analogous to those mentioned in connection with frank attacks, but they occur almost constantly, and have a character of greater gravity. The most remarkable are those which occur in the *digestive apparatus:* the tongue becomes red, and dries rapidly, as likewise does the throat, of which the patient complains; the saliva is thin and acid; at the end of several days, when the condition is aggravated, the tongue is covered with a fuliginous deposit, and becomes dusky and crusted (parrot-tongue). Thrush appears often and very rapidly, thick patches cover the internal surface of the cheeks, and especially the pharynx and the soft palate; it has not, however, according to the observation of Guyon, the same prognostic gravity in urinary fever as in other affections. Vomiting and diarrhœa are usually observed; they have a peculiar character of frequency and severity. *Nervous disturbances* may be seen, and, in certain cases, the agitation and delirium end in prostration and coma, as in pernicious attacks. *Disturbances of the respiration and of the circulation*, already mentioned among the complications of frank attacks, are found also in this form, but with a more marked character of tenacity and duration: oppression may be very pronounced; irregularities and intermittency of the heart are usually observed, and although at the beginning the cardio-pulmonary disturbances are not accompanied by any stethoscopic phenomena, it may be feared that, with time, pulmonary congestion with its numerous subcrepitant *râles* will come on, or even true pneumonia.

Analysis of the *urine* shows that the quantity of urea contained in the urine passed at the moment of the attack is below normal; this is shown by many researches which I have undertaken, and to which I shall return hereafter. This diminution of the proportion of urea is absolute. Indeed, during the attack, the quantity of urine excreted is less than at ordinary times; but the secretion resumes its normal quantity and composition after the fever. Quite violent *renal pains* may be observed in some cases, but this symptom is after all quite rare. Pain caused even by pressure in the lumbar region is not constant; Guyon, having carefully sought for it in a great number of patients, met with it in only a third or fourth of the cases.

There are still other complications which are not met with except in this third form of urinary fever, and much more rarely in the chronic form: these are *simple pains*, and phlegmonous *inflammations* which may end in *suppuration*, and which are ordinarily situated in the skin, the subcutaneous and deep cellular tissue, the joints, the muscles, and certain organs. *Pustular eruptions* of the skin, mentioned by Civiale, are of extreme rarity. Much more frequent are alterations of the subcutaneous cellular tissue. They usually appear in the form of irregularly circumscribed and spontaneously painful *indurations;* they occupy one or more points of the upper extremities especially; the skin which covers them is red, or has kept its normal color; their ordinary termination is resolution; they suppurate only in exceptional cases. The lower extremities, and especially the calves of the legs, are almost exclusively the seat of extremely acute pains, analogous to the pains of rheumatism; they occupy the depth of the limb, being unaccompanied by swelling or redness, and disappear spontaneously, to reappear at longer or shorter intervals.

In addition to these relatively benign complications, there are others more serious. They are happily less frequent, almost rare: they are *suppuration* of the soft parts (cellular tissue and muscles), and of the articulations. According to Marx, the regions where these abscesses of the cellular tissue and of the muscles have been observed, may be thus arranged, following the order of frequency: leg, thigh, buttock, hypogastrium, forearm, precordial region; there is on record only one case of abscess of the iliac fossa, and likewise only one of retro-pharyngeal abscess. As to joint-suppuration, it has been seen in the knee, in the shoulder, in the ankle. These cases are much more rare than those of phlegmon of the soft parts. Finally, *parotiditis* has been sometimes observed, coming on in the last period of urinary fever, and having the same characteristics and the same gravity as in other infectious diseases in which it is customary to meet with it.

Duration and Termination of Acute Urinary Fever.—The frank attack, which constitutes the first type of the acute form, may last from one to three days; its ordinary duration is at least twenty-four hours. Pernicious attacks may be very quickly fatal, and carry off the patient in twenty-four hours. It is much harder to fix an exact limit to the duration of the continuous-remittent form; it varies between these two extremes, five and twenty days.

Death, which is exceptional in the first type and frequent in the second (pernicious attacks), is quite frequent also in the continuous-remittent type. Most of the patients who succumb die with an elevated temperature; in others, there is seen at the moment of death a temperature below 37° C. (98.6° F.). A happy termination is announced by a rapid defervescence in frank attacks; by a slow defervescence, which becomes progressively more marked for several days, in the continuous-remittent fever.

Chronic Form of Urinary Fever.—The chronic form is characterized by moderate, continuous fever, the tracing of which shows very slight oscillations, but which is susceptible, either spontaneously or under the influence of surgical interference, of being replaced by one or a number of grave exacerbations. This form of urinary fever may succeed the continuous-remittent type of the acute form, the grave exacerbations of which disappear for a time, leaving in their place a continuous and not very intense febrile condition; or it may be established from the first, in the latter case its beginning often passing unobserved until the day when a grave exacerbation occurs. The febrile state is usually very slight in the chronic form of urinary fever, the predominant and constant symptoms of which are *digestive disturbances*, and a *peculiar alteration of the general condition.* The appetite is much diminished, digestion is laborious, the tongue is foul and covered with a thick coat, the mouth is sticky and dry. At the same time the patient grows thin, and acquires a yellowish, cachectic tinge, but not icteric. Upon the foundation of this slightly febrile and principally gastric condition, there break out, at irregular intervals, more or less pronounced exacerbations, after which the fever resumes its continuous type, and so on to the recovery or death of the patient. Although in this slow form of urinary poisoning suppuration in the limbs and in the joints is very rarely seen, nevertheless it is more grave than the acute form. Death usually takes place by a return to the acute state, or more rarely by progressive wasting and cachexia, in which case the patient succumbs with a reduced temperature.

Etiology of Urinary Fever.—Urinary fever presents itself in two conditions: sometimes it appears spontaneously; sometimes it follows an operation or the simple use of a sound. It is hardly ever seen in frankly acute diseases of the urinary passages. These diseases (prostatitis, urethritis, and even cystitis) may indeed be accompanied by a very pronounced febrile state, but that is a common inflammatory fever, which it is important not to confound with urinary fever; the first has a regular course, in which defervescence rapidly follows surgical intervention; the second is irregular, with exacerbations. The distinction is usually easy; it may be made even when the two febrile states coincide—when, for example, a urinary abscess or urinary infiltration has developed in a patient with old urinary disorder, who is being consumed by the slow form of urinary fever; but the diagnosis is very difficult when infiltration of urine is complicated with pyæmic manifestations, the febrile type of pyæmia bearing a very strong resemblance to that of urinary fever. These are very difficult cases, but, happily, they are rare.

(1) *Spontaneous Fever.*—Urinary fever is seen especially in chronic diseases of the urinary passages: strictures, prostatic hypertrophy, calculi; and even then it does not appear until an advanced stage of the malady, when troubles of micturition and consecutive lesions of the urinary apparatus have come on. Thus it is that, in patients with stricture, and in those with prostatic disease, it appears at that period of the malady in which the bladder can no longer empty itself completely. Chronic cystitis, which is usually due to incomplete retention, constitutes a frequent condition of urinary fever. As to vesical calculi, their influence in relation to the production of urinary fever varies with one subject or another, without it being possible to fix the reasons for these variations. Certain calculi remain for a long time without febrile complications, others soon show symptoms of fever in its slow form. As to neoplasms of the urinary organs (fungus, cancer, tubercle), it is the secondary lesions which they determine, that provoke urinary fever.

(2) *Provoked Fever.*—All operations, even the most simple, may provoke urinary fever: sounding, or simple dilatation, either temporary or permanent, of a stricture of the urethra, suffices to provoke a frank attack of urinary fever; fruitless efforts to pass a bougie through an impassable stricture, too prolonged or too rough manipulations, the introduction of too large an instrument, constitute so many possible causes of the appearance of fever. Frank attacks are the consequence of internal urethrotomy in a third of the cases, according to Guyon; they usually break out between the second and third day, in the twelve or eighteen hours which follow the removal of the catheter; they appear more frequently when no retained catheter is used after the operation. A clumsy or brutal evacuatory catheterization may cause an attack, which may likewise supervene, although more rarely, after the most irreproachable use of instruments. Complete evacuation of a bladder which has been long distended by urine, is a condition quite favorable to the production of an attack. In lithotrity urinary fever is almost constant, especially after the first two sittings, and its severity is generally proportioned to the length and difficulties of the sitting; the engagement of an irregularly shaped calculus in the urethra, necessitating great efforts in urinating, may very rapidly provoke the appearance of an acute attack.

Pathogenesis of Urinary Fever.—Four principal theories have been proposed to explain the pathogenesis of urinary fever. Although Velpeau, after having indicated certain urinary accidents, and discovered the pathological bond which connected them with alterations of the urinary apparatus, attempted to explain them "by the re-entrance into the current of the circulation of some of the constituents of the urine," he was not followed in this path, and the majority of surgeons invoked, with Chassaignac, *phlebitis* of the very vascular tissues of the region. At a somewhat later period, Reybard first, and then Bonnet, of Lyons, struck especially by the symptoms of general exhaustion and of depression of strength, invented the theory of *nervous exhaustion* by reflex action, analogous to the theory of shock, invoked to explain the general accidents which accompany great traumatisms. The third theory, which has nowadays a great number of partisans, is that of *urinary absorption*, expressed for the first time by Velpeau, and defended in the thesis of one of his pupils. In his work, which reflects the opinions of his master, Perdrigeon plainly attributes the febrile manifestations to the introduction of a certain quantity of urine into the blood, but he leaves unsettled the point of determining whether this vitiation of the blood is produced by absorption of fully formed urine, or by a defect of elimination in the work of the kidneys. It is between these two hypotheses that we must still hesitate.

Whilst, by the works of Maisonneuve, de Saint-Germain, Sédillot, and Reliquet, the theory of direct absorption of wholly formed urine by a point of lesion in the urinary passages, is definitively proved, a fourth theory, already vaguely indicated in the thesis of Perdrigeon, is coming forward. This is the *renal theory*. In 1856 Verneuil found lesions of the kidneys at the autopsy of a patient who had died of urinary fever after the use of the sound, and he inclined to refer the accidents observed during the life of the patient to the functional disturbance of the kidney. Not long after, Bron[1] rejected entirely direct absorption of fully formed urine, and admitted exclusively a defect in the depuration of the blood, by a disturbance of reflex origin in the secretion of urine. Civiale (1860) distinguished between urinary fever independent of any surgical operation, and which may be due to nephritis, and that other urinary fever which he calls *urethro-vesical fever*, which is due to absorption by the urethra and bladder of stagnant and more or less altered urine. In the works of Philips, Mauvais, and especially Marx, the exclusively renal theory predominates; Dolbeau (1864) declares himself thoroughly convinced of it; Malherbe (1872) defends it resolutely in his thesis. But shortly afterwards Gosselin and Reliquet affirm again the direct absorption by torn mucous membranes, and Gosselin insists especially upon the part played by alterations of the urine.

The two theories of phlebitis and of nervous exhaustion belong to history, and are absolutely untenable; there remain the theory of direct absorption and the renal theory; equally rational, equally in accord with recent advances relative to the pathological physiology of fever, they both make urinary fever the result of a systemic intoxication with the constituents of the urine; the first admits the resorption of these constituents by a point of lesion in the urinary passages, the second maintains their non-elimination by a chronically altered kidney, or by one the function of which is temporarily disturbed by a passing congestion of reflex origin. The latter has on its side the experiments of Claude Bernard and of Barreswill,[2] showing that after nephrectomy the proportion of urea increases sensibly in the blood, and that the increased gastric and intestinal secretions then become the channels for its elimination; whence the gastric symptoms, the digestive disturbances, the diarrhœa, and the vomiting, which are soon observed in animals which have undergone ablation of the kidneys. On the other hand, the experiments of Kuss and Susini[3] have proved the possibility of direct absorption, by establishing clearly that if the vesical mucous membrane is devoid of all absorbing power in the state of health, it is far from being the same when the epithelium is altered or destroyed.

It is between these two theories, then, that it is proper to choose, or rather it is necessary to subject them to the clinical test, and to see if one of them can explain, to the exclusion of the other, the various occurrences of urinary fever. The acute, frank attack—that, for example, which follows catheterization with too large an instrument, or an ill-managed one, or, again, the passage of a bougie which has produced an abrasion of the canal—can hardly be explained by direct absorption. How is it to be supposed, indeed, that this delicate abrasion has been able to become the door of entrance to so rapid a poisoning by the urine, even if this were altered, alkaline and ammoniacal, when it is not manifested when an infiltration of urine has extensively invaded the cellular tissue? In fact, to explain the penetration of the urine into the tissues by so small a door of entrance, arguments have been founded upon the efforts necessitated by micturition which has become difficult; or again, upon the permanent presence of an instrument completely filling the calibre of the urethra; but extravasation of urine takes place almost without hindrance in infiltration.

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[1] Gaz. Méd. de Lyon, p. 343 *et seq.* 1858.

[2] Leçons sur les Liquides de l'Organisme, p. 31 *et seq.* Paris, 1859.

[3] Susini, De l'Imperméabilité de l'Epithélium Vésical. Thèse de Strasbourg, 1867.

Considering that it has been possible, in some cases of rapid death, to determine the presence of an intense congestion of the kidneys, which presented here and there small hemorrhagic foci, and that, on the other hand, my researches have shown that there is a considerable diminution in the proportion of urea in the urine voided at the time of an attack, at the same time that there is a notable augmentation of its proportion in the blood, we are led to the conclusion that in these cases the renal theory, which assumes the intervention of a vaso-motor disturbance of reflex origin, is the only one acceptable. But can an absolutely healthy kidney, under the influence of so slight an excitation, become the seat of a reflex congestion intense enough to give rise to the frank paroxysm? I have some doubt in regard to this, all the more because there are quite a number of cases in which the febrile outbreak does not occur, although the same cause of excitation may exist. On the other hand, the explanation does not appear to me to be doubtful in pernicious attacks which are produced by the same mechanism acting on an already altered kidney.

In the continuous-remittent fever which constitutes the third type of the acute form, the febrile state is continuous, with more or less frequent repetitions of the exacerbations. These exacerbations often come on without surgical provocation; they sometimes coincide with changes or excesses of diet. Absorption pure and simple cannot be invoked, and it is more rational to think that it is the renal lesions that keep up the febrile state, or, to speak more correctly, the continuous state of *uræmic intoxication*, which is also demonstrated by the various phlegmasiæ observed in the course of this type of urinary fever.

The pathogenesis of the chronic or slow form is more complex: here, indeed, there coexist almost constant renal lesions and stagnation of urine, in a bladder chronically inflamed, that is to say, which has become permeable and has been indued with absorbent power. The disease is spontaneous, almost apyretic, characterized specially by general phenomena, gastric disburbances, and progressive emaciation. Is it not logical to think that there is in such cases a veritable urinary poisoning (*urinæmia*), produced by direct absorption of a more or less altered urine? And, as at the same time the kidneys are diseased, let any excitation whatever supervene, and there may be seen to come on suddenly, by the mechanism of renal congestion, the gravest accidents, and sometimes rapid death.

It is, therefore, not well to adopt either theory to the exclusion of the other, but to recognize that both appear to be necessary to explain two very different forms of urinary fever.

Treatment.—Study of the conditions in which urinary fever is developed shows that if it sometimes appears spontaneously, it is oftener provoked by surgical interference; the circumstances in which it is apt to occur have been carefully noted, and among them have been mentioned certain modifications of the general condition. It results from these considerations that the surgeon ought to be sure, by fulfilling certain medical indications, to place his patient in the most favorable conditions; and that, on the other hand, he should avoid in his intervention the manœuvres and procedures which have appeared to be of a nature to favor the development of urinary fever. The treatment should be above all *preventive*, and *medical* as well as *surgical*. The preventive therapeutic indications ought especially to attract attention: the disease once declared, the surgeon has hardly anything to do but to recommend palliatives, or to gather indications for operative intervention.

The *preventive surgical treatment* consists essentially in adopting measures of prudence, before, during, and after an operation. *Before operation* the patient should be obliged to take a rest of several days, longer or shorter, according to the nature and importance of the operation to come. A simple examination of the urethra may, if necessary, be made off-hand, but a minute exploration of the urethra, and still more one of the bladder, demands preparation on the part of the patient. The time of resting may be employed in preparing, by the introduction of bougies with a progressively increasing diameter, the organs to undergo the passage and contact of more voluminous and harder instruments. Civiale, who took several days before carrying an instrument all the way into the bladder, has laid down, on this subject, some very wise precepts, which may be summed up in these three words: slowness, patience, gentleness. It is unnecessary to say that force, even in the very smallest degree, ought never to be employed to cause an instrument to pass. The rapid passage of a bougie or catheter, besides that it may be injurious, is useless, the surgeon not having time to recognize the sensations which he ought to get from his instrument. These rules should be even more rigorously observed when exploration of the bladder is concerned.

During the operation the same rules should be applied, that is to say, pains should be taken to diminish as much as possible the duration of the operative manœuvres, and to regulate, with jealous care, the degree and duration of instrumental contact (Guyon). Although urinary fever cannot be attributed to shock of the nervous system, it is wise to diminish or to completely suppress pain, either by an injection of morphia, given half an hour before the operation, or even by anæsthesia; the patient will come out less fatigued from an operation which has been made easier by means of the anæsthetic sleep.

After the operation there are two capital indications: (1) to avoid chilling, which, even if slight, suffices to provoke a febrile attack; (2) to oblige the patient to take absolute rest in bed for one or several days. Is it necessary to add that the practice of certain specialists, who not only make minute explorations but even perform operations in their offices, is to be condemned in the highest degree?

At the same time that he takes these precautions, the surgeon ought to attend to the *medical indications:* the symptoms in the digestive canal, so often associated with the beginning of urinary intoxication, should be combated, if possible, by saline purgatives and the bitter preparations; the regular performance of the function of the skin should be reëstablished by warm baths and dry frictions. It is an absolute rule to examine the urine, both as to its quantity and as to its quality; if there be opportunity, diluent and very slightly diuretic drinks should be administered; alkalinity of the urine should be combated with boric acid, given by vesical injection, or internally, in doses of a gramme or a gramme and a half, if the condition of the digestive canal permit. There are nervous, cowardly patients, whom the sole fear of an operation puts in a state of deplorable agitation: bromide of potassium in large doses will produce the necessary sedation. Exaggerated sensitiveness of the genital organs, local irritation—which may be an obstacle to the free manipulation of instruments—may be advantageously combated with opium, with morphia in injections, with enemata containing laudanum, or with suppositories containing belladonna or chloral. It is customary to give the sulphate of quinia in larger or smaller doses in the course of the fever: it is also given for the purpose of prevention, the evening before and the day of operation. This is an excellent practice, which has not perhaps all the anti-febrile efficaciousness which has been attributed to it, but which it is well to continue, if it be only to act on the *morale* of the patient.

Curative Treatment.—When urinary fever has once appeared, its treatment is most frequently medical, but sometimes surgical. As soon as a frank attack occurs, it is necessary to warm the patient up, and to provoke sweating by making him take stimulants; a warm infusion rendered slightly alcoholic, and especially tea with a little rum or brandy added. The sulphate of quinia, in small doses frequently repeated, ought always to be employed. When the attack is over, it is well to administer a saline purge.

In the continuous-remittent form, and in the chronic form of urinary fever, the treatment varies according to the condition of the digestive tract. It is of prime importance to take pains to sustain and feed the patient; milk diet often gives good results. For the renal pains which are met with in some cases, cataplasms, or dry or cut cups, may be employed with success.

The appearance of one or more paroxysms of urinary fever may be an express indication for surgical interference, whenever the surgeon judges that interference to be capable of suppressing the cause of the fever. These conditions exist in cases of obstruction to the voiding of urine—strictures, tumors of the prostate, etc. Urethrotomy, divulsion, or the retention of a catheter, may then cause the immediate disappearance of the febrile paroxysms.

Exclusive of these conditions, the appearance of fever is often a contra-indication to all operative acts; but it is necessary to distinguish between the different clinical types of urinary fever. Frank, acute attacks, or the continuous-remittent fever, are only temporary contra-indications, which only compel the surgeon to defer the time of operation for a few days. But urinary fever in its slow form, indicating advanced alterations of the kidneys, may be an indication to modify the method of operating as—for example, to substitute lithotomy for lithotrity—or even to abandon all idea of interfering, when the duration of the fever, the renal pains, the alteration of the urine, and the general condition, testify to an already advanced degree of the renal lesions.

INJURIES AND DISEASES OF THE MALE GENITAL ORGANS.

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INJURIES AND DISEASES OF THE PENIS.

WOUNDS OF THE PENIS are to be treated on general principles. The wound is to be well sponged and freed from clot, dirt, or any foreign body, the bleeding stopped by means of fine catgut or other ligatures, or by torsion, and the edges of the cut placed in accurate apposition by fine sutures not passed too deeply. The wound may be superficial, and the bleeding but slight; if, however, the dorsal vessels be divided, it may be free for the time, but is easily arrested by tying the vessels and dressing the wound. Blood may be effused under the skin and produce a dark-colored swelling like a traumatic aneurism. If the body of the penis is deeply incised, the after-consequences are grave, as the organ, owing to the substitution of fibrous for the firm trabecular tissue of the part, becomes bent in erection. The case is much aggravated if the urethra be injured as well as the body of the penis. M. Baudens recommends an incision of the required depth to be made directly opposite the point of curvature, in order to procure a cicatrix capable of counterbalancing the evil caused by the injury.

Incised wounds of the penis are made longitudinally by the surgeon for the division of strictures, for the extraction of urethral calculi or of foreign bodies introduced from without, and in the median operation of lithotomy. The bleeding is free at times, when the tissue of the bulb, or its artery, which is readily tied, is wounded. The most common direction for wounds of the penis to take is the transverse or oblique; they are at times inflicted by jealous women, and often by patients themselves, in cases of monomania. Owing to the mobility of the part and the toughness of its fibrous tissue, and possibly to the want of sharpness of the instrument used, the wound is very irregular and the mutilation imperfectly performed.

Monomaniacs display great determination in committing self-mutilation, and often effect the separation of the parts with singular instruments. My brother, Dr. John H. Bell, met with the following case :—

An Irishman castrated himself with a pair of blunt nail-scissors ; the hemorrhage was great, but would have been greater had a sharper instrument been used. The whole of the external genitals, including the scrotum, penis, and testicles, were removed; the urethra was cut straight across ; there was a clean surface, and urine was retained as before. He subsequently grew fat and sleek, and sank into a state of satisfied imbecility.

In India it is the custom for some Mahomedans to be made eunuchs:—

Young boys are brought from their parents, and the entire external genitals removed with a sharp razor. The bleeding is treated by the application of herbs and hot poultices; hemorrhage kills half the victims, and at times brings the perpetrators of the vile proceeding within the clutches of the law.

If the parts have been completely severed and the wound left be irregular, the surgeon should trim it up, adjust its edges accurately with silver-wire sutures, remove any foreign material, tie all the vessels, and divide the lower wall of the urethra for about half an inch, stitching the edges of the mucous membrane and skin together, to insure a patent orifice. It is necessary carefully to compare the appearances presented by the wound with the account given of the mode of its occurrence: a case has occurred but recently where two men were committed to prison for mutilating a man, who, in the sequel, was proved to be a monomaniac, and to have committed the act himself.

If there be a wound of the urethra, its edges should be brought together and a suitable gum-elastic catheter retained. In some instances a urinary fistula, in others an awkward curvature on the side injured, may result. If retention of urine follow an injury, a catheter must be used.

Punctured wounds of the penis are very rare, and may result from pins, needles, or from pointed objects introduced into the urethra, and in battle from sword or bayonet thrusts. The wound is attended with sharp pain, and may eventually produce distortion of the penis like an incised wound.

Contused wounds are caused by severe pressure from a blunt body, such as a cart-wheel, by a blow from a piece of timber, or by the kick of a horse. When severe, the lesion is very formidable, as the urethra is likely to be ruptured, and there is extensive swelling from extravasation of blood. Analogous to the lesions produced by a contused wound is that due to *strangulation*:—

A young man has been known to tie a piece of string around his penis to remedy nocturnal incontinence of urine: the organ swells during sleep, and it becomes a difficult matter in consequence to untie the string, which causes œdematous swelling and ulceration, this soon opening into the urethral canal and giving rise to a distressing fistula. It was only after a very careful examination that Mr. Wormald detected and removed a constricting foreign body which had become deeply buried by ulceration in a boy's penis; the boy stoutly denied all knowledge of its presence.

A fistula at the base of the glans is sometimes met with in children, which appears on examination to have been caused by the constriction of the detritus of clothing, which has become matted together and formed a cord.

Mr. Potts[1] reports the case of a man who applied to him to be relieved of retention of urine. A woman had passed, a few hours before his application, a ring over his penis. The organ was greatly swollen and discolored, the glans being quite black; the ring was deeply imbedded in the tissues about two-thirds of the distance from the orifice. After a little trouble, a fine grooved director was passed under the ring, which was filed across and removed. The ring was a gold "keeper," and had on its inner surface the not inappropriate motto "No separation until death." The man immediately passed a large quantity of urine, and suffered no ill effects afterwards.

An injury to the penis may occur during coitus and be followed by extravasation. Injuries to the perineum leading to rupture of the urethra and extravasation of urine are very dangerous, and are to be treated by passing a catheter at once into the bladder before extravasation has taken place. The same care is necessary in the treatment of injuries of the urethra associated with fracture of the pelvic bones.

Gunshot wounds of the penis are but rarely met with in civil practice. The course of a bullet in the penis is as eccentric as it is in other instances of gunshot injury. The glans penis may be removed, or the ball may traverse the body of the penis leaving the urethra untouched, or the whole organ may be carried away. The hemorrhage is not excessive, but inflammation and suppuration ensue, and cause swelling and attacks of retention. As in other parts of the body, the ball is to be removed and the wound dressed with a mild disinfecting lotion. Bullets may become encysted.

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[1] Trans. Path. Soc. Lond., vol. xv. p. 155.

Lacerated wounds of the penis are very severe, and may be caused by the penis being caught between two revolving cog-wheels which lacerate the organ and the parts around. They are attended by severe inflammation and suppuration. Wounds caused by the bites of animals are peculiar, as often the part is not cleanly bitten through, the corpora cavernosa giving way more readily than their tough coverings; there is a combination of tearing and biting. An interesting case is cited in Bryant's Surgery:—

The patient, a man aged 50, when 19 years old had his penis bitten by a stallion; a fleshy, cylindrical mass, an inch and a quarter long and one-third of an inch in diameter, projected from the orifice of the urethra, and was evidently the everted end of the corpus spongiosum, the main part of which terminated abruptly one inch behind the glans penis. The urine flowed by the side of the protrusion.

FRACTURE OF THE PENIS is said to occur when the organ is forcibly bent when in a state of turgescence. It may occur to a drunken man during connection, by his "missing his mark", as in a case mentioned by Mr. Bryant; or may be done out of mischief, and in some cases is said to be done to relieve a chordee—a most dangerous proceeding which leads to organic stricture. Rupture of the penis is attended by a distinct sound, the organ becomes flaccid, and extravasation of blood takes place rapidly and profusely. Dr. Valentine Mott[1] treated two cases successfully by rest and the application of cold to the part. Van Buren and Keyes[2] recommend a stout gum-elastic catheter to be retained in the urethra and bladder, firm pressure to be made by means of adhesive strapping, or collodion, or both, and cold to be applied locally. It is unadvisable to make incisions into the part, as they will lead to suppuration, but they must be made antiseptically should suppuration threaten. The penis is left in a damaged condition, owing to the deposit of fibrous tissue.

A man, aged 30, struck his penis during coitus against his wife's pubes. When seen, his penis, much enlarged, was the seat of an extensive extravasation of blood. The skin was distended to such an extent that gangrene threatened, and the first act of the surgeon therefore was to incise it. The urine was drawn off with difficulty, and the instrument was retained. A portion of the prepuce and sheath of the penis became gangrenous, and urinary abscesses followed. The patient recovered, but during erection the penis was very awkwardly bent.[3]

LUXATION OF THE PENIS is a very rare and curious accident; the term luxation is not strictly a correct one, as the penis does not articulate with any portion of the body, but is attached to the pelvis by its crura and by strong ligaments. M. Nélaton has, however, described the accident under the above designation.

There are a cast and a drawing of a remarkable case of the kind in the anatomical museum of King's College. The scrotum and penis are from a well-developed adult. The penis is normally situated, but is wrinkled and shrunken, looking as if it were without the corpora cavernosa, and would doubtless feel soft in the living subject, owing to the absence of those bodies. On the right side, in front of the right testicle, the scrotum has given way in consequence no doubt of ulceration, and through the opening a well-formed glans penis with its urethral orifice is to be seen, and behind it the body of the penis. The glans penis is devoid of prepuce, and the body of the penis of its natural integumentary covering. Judging from the appearances presented by the cast, one would say that the cavernous portion of the penis had been in some way forced out of its cutaneous envelope, into the scrotal cellular tissue on the right side, and that there, owing to extravasation of urine or the irritation caused by its presence, sloughing had ensued and had liberated the penis. (Fig. 1355.)

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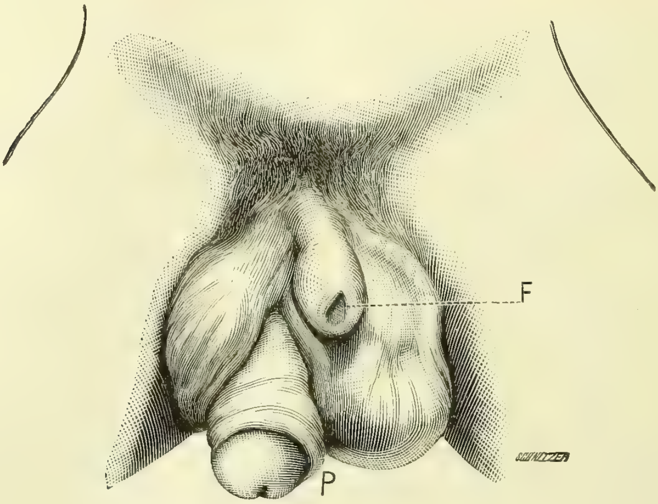
[1] Transactions of the New York Academy of Medicine, 1851.

[2] Treatise on the Surgical Diseases of the Genito-Urinary Organs, etc. New York, 1874.

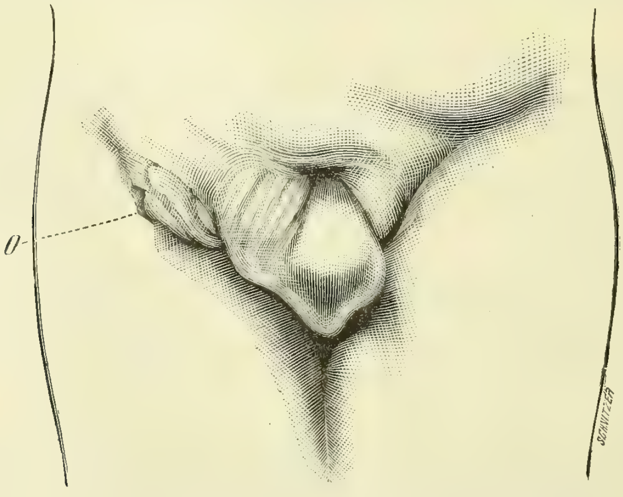
[3] Pilore, Lo Sperimentale, Ottobre, 1881.

Fig. 1355.



Dislocation of the penis. *F.* foreskin and skin of penis; *P.* penis deprived of its prepuce and cutaneous covering. (From a drawing in King's College Museum.)

Fig. 1356.



Dislocation of the penis. At *O* is seen the opening of a sinus through which the urine was discharged. (From a patient under the care of Sir. W. Fergusson.)

The case illustrated in Fig. 1356 occurred in a younger patient, a boy about 14 years of age. There was no penis to be seen, but some irregularities in the pubic and subpubic regions. In the right groin was a small opening, about the size of a probe, through which urine was passed. On careful examination, Sir William Fergusson detected the peculiar gristly sensation communicated by the presence of the body of the penis. He carefully dissected out the organ, and, having covered it with integument, reinstated it in its normal position, much to the comfort of the unfortunate youth. This patient must have been subjected to some severe, compressing force, which stretched and injured the skin, and forced the penis subcutaneously into its new position, where a fistula for the escape of the urine was formed at a later date.

These cases are to be rectified at the time of their occurrence, an attempt being made by means of a director to slip the corpora cavernosa back into their normal skin envelope. Incisions are to be made wherever the surgeon may deem necessary, in order to replace the organ.

Foreign bodies are found in the urethra; those most commonly met with come from within, in the form of calculi, which may become encysted, and gradually increase in size and number, being facetted. These should be removed by a longitudinal incision over their resting place, as the force necessary to withdraw them through the urethral canal would be such as to injure the passage and set up violent inflammation and sloughing of the penis. Foreign bodies are at times introduced into the urethra from without by the patient himself, and must be removed by suitable means.[1]

Preputial calculi, sometimes in great numbers, are found under the foreskin, where they are moulded on the surface of the glans penis. The prepuce is much enlarged, and being contracted at the orifice, the escape of the calculi is prevented. The diagnosis is easily made, as the stones are readily felt with a probe, and are at once set free and the phimosis removed by slitting up the foreskin. In some instances it is necessary to break up the calcareous ring which surrounds the corona glandis. In size, the stones have varied from one to six inches in circumference, and Sir B. Brodie in one case counted as many as sixty.

In cases of congenital phimosis, the secretion of the glandulæ odoriferæ becomes thickened and dried on the surface of the glans penis, which it covers like a cap. The foreskin should be slit up or circumcised, and the material removed, as then its reaccumulation will be prevented, and the part can be kept properly washed.

Balanitis and Posthitis.—The first term is applied to inflammation of the glans penis, and the second to inflammation of the mucous membrane lining the foreskin; the two conditions are often associated. The most common causes are want of cleanliness owing to phimosis; the contact of some irritating secretion, such as the smegma præputii, or gonorrhœal or other discharges; and the irritation caused by incontinence of urine. There may be a thick and profuse discharge, but there will be no scalding on making water, as in gonorrhœal urethritis, nor will there be chordee. The internal surface of the prepuce and the surface of the glans penis can be seen, the epithelium being stripped off in places. The part is sore and itches, and the urine when it passes causes some smarting. The ulceration is merely superficial, and soon yields to cleanliness and astringent applications. The inguinal glands may enlarge slightly, but are not likely to suppurate; when warts are present, there is a profuse, offensive discharge, which acts as an irritant to the parts around.[1] Adhesions after ulceration are met with in children, but not after balanitis in the adult.

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[1] See page 450, *supra*.

Inflammation of the penis (*penitis*) is said to follow on typhoid fever. The organ is painful, red, and much swollen, and there is constitutional disturbance. The complaint terminates by resolution or by the formation of abscesses, or even by the sloughing of the organ; at times pyæmia may ensue. Antiphlogistic remedies are to be employed at the onset, and incisions and other means as the occasion arises.

Abscess of the penis may occur from injury, but is more often associated with gonorrhœa. A small, hard lump will form, generally at the fossa navicularis or at the bulb of the urethra; there are smarting and pain on making water. As soon as it is evident that pus has formed, or is about to form, the swelling is to be punctured, and then fomented and poulticed, in order to minimize the chance of the formation of a urinary fistula. If opened early, a free exit is given to the pus and urine, burrowing of matter and extension of the abscess are prevented, and, as a rule, the opening will contract and heal. In some cases the loss of tissue, owing to the size of the abscess, is of consequence, and the opening into the urethra is free and followed by an obstinate fistula; this should be treated by touching it with a red-hot wire, and by preventing the passage of urine through it by the constant use of the catheter.

In one case, after the use of a strong injection, a lacunal abscess formed in the spongy part of the urethra, just in front of the scrotum, and opened externally. It healed in due course, but the loss of spongy tissue was attended by a slight bend in the penis when erect. Cases of urethral abscess are attended by an indurated condition of the body of the penis, probably from the irritation set up by a slight extravasation of urine into its tissues. This is not a common complication, but I have met with such a condition, in an aggravated form, after immediate dilatation of the urethra for a tight stricture; the man informed me that his penis was depressed when turgid, instead of being erect, and that copulation was thus interfered with.

An abscess with extensive sloughing of the skin and urethra may follow extravasation of urine, and the same result may follow the retention of a silver catheter, used to dilate a tight stricture.

A severe case of sloughing of the urethra and skin of the penis was sent to King's College Hospital from the country, to be under my care. The history given was that a silver catheter had been passed through a tight stricture at the bulb of the urethra, and had been tied in the bladder. In a day or two sloughing took place, and destroyed the urethra and skin, leaving a large opening which extended along the perineum from just in front of the anus, through the scrotum, to an inch and a half in front of it, the opening being about three inches and a half in extent. The patient was under treatment for many months, and was repeatedly subjected to plastic operations; I have since heard that he is quite well. The mode of remedying these cases is treated of elsewhere.[2] This case teaches us that caution is very necessary when an instrument is retained in the urethra.[3]

Abscesses in the penis, especially in the neighborhood of the bulb, are generally due to gonorrhœa, but may follow a debilitating attack of fever, or an injury; the abscess must be opened early in the usual way.

Gangrene of the Penis.—This affection fortunately is not a common one; the constitutional causes which give rise to it are the exanthematous fevers—

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[1] See Volume II. page 589, *supra*.

[2] See pp. 512, 515, *supra*.

[3] Soft gum-elastic or India-rubber instruments, frequently changed, cause much less irritation than silver catheters.

especially smallpox—poisoning by ergot of rye, and erysipelas. Among the local causes may be mentioned phimosis, paraphimosis, balano-posthitis, inflammation of the penis, wounds, strangulations from constriction, foreign bodies in the urethra, and other injuries of the penis, with or without fracture of the pelvis.

The late Mr. Partridge[1] narrated the case of a man who had lost his entire penis from gangrene occurring with typhus fever. He was a sober man, aged forty years, and had been delirious and unconscious, and indifferently attended for a week; the whole penis, as far as its root, in front of the scrotum, was found to be gangrenous, with a distinct line of demarcation between the living and dead tissues; the mortified part was black, half dry, and collapsed, and looked like the empty finger of an old black kid glove. The urine dribbled from an aperture between the gangrenous and sound parts; the orifice left after separation of the slough, seeming to be disposed to contract, was slit up for one-third of an inch, and its mucous lining stitched to the adjacent skin.

Mr. Gay[2] records a case of gangrene of the entire corpora cavernosa and corpus spongiosum, probably from thrombosis of the iliac vein consequent on rheumatic phlebitis. A cabinet-maker, aged thirty-one, caught cold, his temperature became 100° F., and he had pain in his left calf. In the course of a few days the pain in the calf subsided, but there were swelling and tenderness over the external saphena and femoral veins. The penis now became distended and rigid, the glans being of a dusky hue; the integuments were œdematous, but of their natural color. The glans penis became black; the integument of the organ had retained its vitality, but the cavernous and spongy bodies had perished, and were subsequently removed as a slough. The death of the penis in this case was due to a plug in the internal iliac vein.

The blood-current from the deep structures of the penis has no outflow but through the deep or systemic veins, so that obstruction in these is fatal to the deep parts, but not to the integument. It is probable that an injection will pass from the superficial to the deep veins. In the Transactions of the Pathological Society[3] is given the drawing of a young soldier who had lost the whole of his penis from syphilitic phagedæna; an aperture remained in the scrotum, which looked like a small vagina.

The penis when attacked by gangrene swells, and as a rule the skin becomes discolored, red, and then black; the temperature is diminished, and the sensibility of the part abolished. There is a well-marked line of demarcation, a deep sulcus forms, the living portion of the penis presents a red circle caused by granulations, which are very vascular, bleeding readily when touched, and bathed in healthy pus; the urine is passed through an opening in the sulcus, the slough eventually separates, and the part cicatrizes. In cases of extravasation of urine, the appearance of a black spot on the glans penis is a bad sign. The prognosis in these cases depends on the cause of the gangrene: if local, and if the health be tolerably good, the patient will recover with loss of more or less of the organ. Generally there is a good deal of constitutional disturbance, and a low typhoid condition. The patient is to be treated by the administration of stimulants, tonics, and good and suitable nourishment, and must be kept in bed, in a room of an even temperature. Locally, fomentations may be applied and different kinds of disinfectants used; in some instances a charcoal poultice will be found of service. When the gangrenous portion has separated, the resulting wound is to be dressed according to its condition, and the lower wall of the urethra and skin should be divided for half an inch, and stitched together in order to prevent constriction of the orifice should this threaten.

Erysipelas may spread to the penis from neighboring parts, or may arise from some abrasion or inflammation. The organ is red and swollen, and the patient suffers from pyrexia; the disease runs its course; resolution, abscesses, or gangrene, may ensue as in ordinary cases of erysipelas elsewhere.

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[1] Trans. Path. Soc. Lond., vol. xvi. p. 192.

[2] Ibid., vol. xxx. p. 323.

[3] Ibid., vol. xii. p. 141.

Herpes præputialis is brought about by some local irritation acting on a constitution prone to herpes. The eruption is vesicular, and is attended by slight inflammation and itching; the ulceration as a rule is very superficial, but at times is said to cause inflammation and sloughing of the prepuce; relapses are common. These cases should be treated by introducing lint between the prepuce and glans, and by keeping the parts scrupulously clean by means of warm water and some astringent lotion, such as a solution of acetate of lead, sulphate of zinc, or alum; tannin and glycerine; or red wash (R. Zinci sulph. gr. j; sp. rosmarin. ♏x; sp. limon. ♏x; aquæ f℥j.). Powders of zinc-oxide, calomel, iodoform, etc., are also useful. If the foreskin be long, it must be well syringed out by means of a properly shaped syringe. Gouty remedies are often of use, and the condition of the secretions is to be looked to. In some inveterate cases of herpes, the seat of the eruption, the lining membrane of the prepuce, must be removed.

Congenital Defects of Penis.—*Absence of the penis* is rarely met with, but in cases of epispadia and hypospadia the organ is in a rudimentary condition.

M. Bouteiller, of Rouen, operated successfully on a child born apparently without a penis. On careful examination he found, just below the pubes, a movable body which felt like the penis, and in its neighborhood a depression through which urine flowed. He dissected out the organ and placed it in its normal position. In some instances the urine is discharged at a distance from the normal site, as at the umbilicus, or the canal for the urine has an opening common to it and the rectum. Nélaton met with the case of a child, born without a penis, who had a properly developed scrotum containing testicles, and who passed water through the rectum.[1] Goschler reports a similar case.[2]

Dr. J. W. Hicks observed a fœtus in which both bladder and rectum were without any external opening, but communicated with a pouch projecting externally in the position and form of the scrotum. From this scrotal pouch a narrow canal passed upwards with two openings, one into the bladder and the other into the rectum. Both testes were in the abdomen.

Cases where the penis is *multiple* are very rare.

A case is recorded by Goré, of Boulogne;[3] the penis was double, with the corpora cavernosa placed side by side; each organ was provided with a urethral canal. In Geoffroy Saint Hilaire's case the two organs were also separate, but one was placed above the other, and urine or semen was discharged indifferently by one or the other.

Mr. Ernest Hart's case[4] is fully reported, and engravings are given; the patient was a well-grown, healthy man, who had between his thighs a third limb, formed of a wasted thigh, leg, and foot. In front of the thigh was an ill-developed scrotum, and on each side of it a well-formed scrotum inclosing normal testicles. The penis was double, each organ being well developed and normally situated. The left, the one most in use, was longer than the right. Both became erect under excitement and discharged urine or semen simultaneously. Another interesting case, unassociated with fœtal inclusion, as in Mr. Hart's patient, is narrated by Drs. Van Buren and Keyes.[5]

Mr. Wood found, in a well-developed man, an abnormal urethra an inch and a half long, situated above the true urethra, which was slightly hypospadic. The false urethra occupied the position of the fossa navicularis, of which it was probably a backward development. It did not communicate with the urethra, a double fold of mucous membrane separating the two canals.[6]

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[1] Gaz. des Hôp., 28 Janv. 1854.

[2] Vierteljahrschrift für practische Heilkunde, 1857.

[3] Compt. rend. Acad. des Sciences, 1844.

[4] Lancet, June, 1866.

[5] Op. cit.

[6] Trans. Path. Soc. Lond., vol. x. p. 201.

Congenital Adhesion and Incurvation of the Penis.—In these cases the penis, with the exception, in some instances, of the glans, is inclosed within the scrotum, a webbed condition of the organ resulting. The urine, instead of being projected clear from the body, flows over the scrotum, and, when erection takes place, the corpora cavernosa arch forwards under the skin, and any semen emitted flows downwards, the patient being in consequence impotent. In these cases the surgeon must set free the organ by dissection, planning his incisions so that a covering for the liberated penis may be obtained from the loose, abundant skin of the scrotum, and bearing in mind that the covering must be ample, as the skin is very elastic and freely shrinks when it has been dissected up. Mr. Erichsen liberated a man's penis by cutting through the frænum which tied it down.

Torsion of the Penis is occasionally noticed:—

Mr. John Gay's case was that of a healthy child, aged 8 months. The penis, which was epispadic, had undergone torsion in its axis, so that the under surface presented upwards and to the left, and the child passed his urine towards or even over the left shoulder. The prepuce was ample, and hung in a fold from the penis, which looked as if during fœtal life it had passed through the side of the prepuce some third of an inch behind its orifice, which had been preternaturally closed; the crura of the penis could not be traced.[1]

M. Follin reports a similar case:[2] the boy was 12 years old, had complete epispadia, and the body of the penis was so twisted that "sa face supérieure regardait en haut et à gauche." The frænum had a long prepuce attached to it.

M. Verneuil[3] and M. Guerlain[4] narrate cases of complete torsion of the penis, in which the under surface became uppermost, and the urethra occupied the antero-superior surface of the organ.

Hypertrophy of the corpora cavernosa is more common than their *atrophy* or *absence*, which are very rare. The glans penis is impervious in cases of *deficiency of the corpus spongiosum*, the urethra opening on the anterior surface of the scrotum. When erect, the organ curves with its convexity upwards. The place of the corpus spongiosum is taken by a firm fibrous band. This fibrous cord may be divided, and the condition of the penis improved, but the urethra will remain as before; the patient is necessarily impotent.

In some cases the *prepuce is over-developed*, and in others it is congenitally *deficient* or but partially developed; in some instances it is *cleft*, and in others *adherent* to the surface of the glans, and cases have been met with in which the prepuce was adherent to the orifice of the urethra.

Absence of the prepuce is of rare occurrence, but nevertheless an operation has been proposed and practised, which has for its object the covering of the glans penis with skin, in order to increase its sensibility, which is lessened by the friction to which it is exposed when the foreskin is wanting. The prepuce provided by surgical skill is at best but an indifferent one. When the prepuce is irregularly developed, it may hang in nodular masses of integument above, below, or at the sides of the penis, and may interfere with sexual intercourse. It is a simple matter to remove the tags of skin and to stitch the margins left by the incisions neatly together.

Congenital division of the prepuce sometimes exists. The simplest treatment is to remove the triangular portions formed by the cleft, but, if preferred, the edges may be pared and brought together as in a case of harelip.

Other Malformations of the Penis.—The urethra may fail to open at the glans penis, being absent or blocked by a membrane; or further back it may be converted into a fibrous cord. When atresia is present, a puncture is to be made in the course of the canal with a trocar and canula, and the newly formed canal kept open by bougies. When the urethra is altogether absent and there is no escape of urine through an abnormal channel, an opening must be made into the distended bladder either through the perineum, or better still above the pubis, if the obstruction of the urethra be likely to prove permanent. The formation of a canal in the normal situation may be attempted if the surgeon thinks fit, but these cases are very unpromising, and, when established, the passage must be kept constantly dilated by means of instruments. At times infants are born with imperforate anus, the bowel opening into the posterior part of the urethra, through which some meconium is discharged. A case of this kind was successfully treated by Sir William Fergusson, by passing a director down the urethra and laying open the canal and rectum in the perineum.

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[1] Trans. Path. Soc. Lond., vol. xvi. p. 189.

[2] L'Union Médical, 30 Sept. 1862.

[3] Bull. de la Société de Chirurgie, 1859.

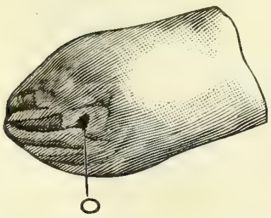
[4] Bull. de la Société Anatomique, 1859.

Hypospadia and epispadia are considered in the article on Injuries and Diseases of the Urethra.[1]

Phimosis and Paraphimosis.—*Congenital phimosis* is due in most cases to an excess of development of the foreskin, the orifice and mucous lining of which are tight. The foreskin will not pass backwards and uncover the glans, even when the penis is flaccid, and owing to its pressure the organ is but ill-developed. In some instances the orifice of the prepuce is wanting: the urine then collects within it, causing its distention; the penis becomes erect owing to the pressure and irritation; and the child is in great distress. If allowed to remain, sloughing would eventually take place, but this is prevented by the surgeon, who slits up or circumcises the foreskin according to its conformation.

In some instances the foreskin is not redundant, but presents a contracted orifice, constituting another variety of congenital phimosis, to which the term *atrophic* has been applied. The foreskin may be too tight to be drawn back over the glans when the penis is distended, or it may be in that dangerous condition which admits of the glans being uncovered with difficulty. In these cases, on connection, the foreskin is forcibly retracted over the glans penis, which rapidly swells and prevents reduction by the patient, a condition of paraphimosis resulting.

Fig. 1357.



End of foreskin removed entire, and distended. The pin-hole-like orifice of the prepuce is well shown at *o*.

In infants, the prepuce is normally redundant, but as long as the glans penis can be uncovered, all will come right when the organ is more developed. In cases of *atresia præputii*, or when the orifice of the prepuce is smaller than that of the urethra, and the prepuce is distended whenever the child urinates, circumcision should be done. The operation is performed as a religious rite amongst the Jews, and is rarely attended with an accident, though occasionally a child dies of hemorrhage or erysipelas. Owing to the induration of the glans penis, masturbation and syphilis are less rife amongst the circumcised than the uncircumcised.

Acquired phimosis may follow inflammatory attacks due to gonorrhœa, balanitis, or chancroids beneath the foreskin. A series of chancroids or ulcers around the orifice of the prepuce, when healed, will give rise to so much contraction that a well-marked phimosis will result. Œdema of the prepuce from inflammation, or from heart-disease, will cause a formidable-looking phimosis.

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[1] See pp. 487, 496, *supra*.

An old man was admitted into King's College Hospital under Sir Wm. Fergusson's care, with thickening of the foreskin, contraction of its orifice, and incontinence of urine; the foreskin was removed, and the man was relieved of his vesical symptoms.

A thickened condition of the integument of the penis and foreskin is at times associated with chronic and repeated attacks of cutaneous syphilis; this condition is to be treated with anti-syphilitic remedies. When the phimosis is due to some inflammatory cause, the best treatment is to remove the inflammation by rest, elevation of the penis, and the free use of injections with a suitable syringe. It is not advisable to operate on the foreskin when it is acutely inflamed, or when the parts are very œdematous, as the wounds will gape a good deal and be slow to heal. In such cases stitches are of little value. As a rule, when chancroids are concealed beneath the foreskin, a cutting operation is not advisable, as the wound would take on chancroidal action and heal slowly. In cases of acute inflammation, however, when it is evident from the swelling, pain, and redness, and from the offensive nature of the discharge, that a sloughing chancroid is hidden under the tight foreskin, the sooner this is slit up or circumcised the better, as the tension caused by the swelling of the part will be relieved, and the sloughing sore will be exposed for the efficient application of suitable remedies. These formidable-looking cases rapidly get well when so treated. When the foreskin sloughs and the glans penis protrudes through the opening, the prepuce is to be removed. The foreskin when distended with warts, due to gonorrhœa, or with calcareous matter, is to be slit up and the offending bodies removed. At times the warts are unfortunately of a malignant type, this kind being generally met with in persons with long foreskins.

The irritation set up in cases of phimosis by the retained smegma præputii, or by the passage of urine, may cause a number of reflex symptoms, and may induce the patient to masturbate. The difficulty in passing water produces irritability of the bladder, frequent micturition, a tendency to rupture, prolapsus of the rectum from straining, and all the symptoms of stone in the bladder. In some cases there is incontinence of urine, attended with hæmaturia. Dr. Sayre has published some cases of curvature of the spine in children, suffering from priapism due to adherent foreskin. Professor Erichsen has seen, in children, general spasmodic affections resembling chorea, and resulting from congenital phimosis; and has attributed to the same cause, in adults, an improper retention of semen during sexual intercourse. A phimosis will render the treatment of gonorrhœa or chancroids tedious and unsatisfactory.

Treatment of Phimosis.—*Dilatation of the foreskin* has been effected by means of tents of compressed sponge or of laminaria digitata. M. Nélaton[1] advocated the treatment of phimosis by forcible dilatation with instruments, and the same plan has also received the advocacy of Cruise, of Dublin.[2] After its forcible dilatation, the prepuce is drawn back behind the glans penis and retained there.

The *mucous membrane* only, of the foreskin, has been divided with a pair of scissors. The sharp-pointed blade, the upper, is to be thrust into the cellular tissue between the mucous membrane and the skin, and the lower or blunt-pointed one, between the mucous membrane and the glans. M. Faure arrives at the same result by drawing the foreskin forcibly back towards the base of the penis, and making a succession of nicks in the mucous membrane until the glans is quite uncovered. The plan of dividing the mucous membrane only, is not, in my judgment, to be recommended.

A *slitting-up* operation is most applicable to cases of atrophic phimosis;

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[1] Gaz. des Hôp., 1868.

[2] Dublin Quart. Journ. of Med. Sci., vol. xviii. p. 482.

the operation is usually done by slitting up the prepuce in the middle line, on the dorsum, but Mr. Liston was in favor of dividing it on one side of the frænum, as that sufficed to correct the contraction and yet allowed the prepuce to cover the glans. Jobert (de Lamballe) and others have divided the prepuce on both sides of the frænum. The operation is to be performed with a sharp pair of scissors, or with a director and a sharp bistoury; care is to be taken to divide the mucous membrane completely, and to stitch it carefully to the cut margins of the skin. Dr. R. W. Taylor[1] makes, with a strong pair of scissors devised by himself, two incisions, one on each side, exactly in the middle of the lateral portion of the prepuce. Two flaps, an upper and a lower, are formed, which enable the glans to be completely uncovered. If the flaps prove to be redundant, they may, after the subsidence of inflammation, be trimmed to suit the requirements of the case. Van Buren favors the removal of the foreskin, in adults, by making two cuts, one on the dorsum and the other near the frænum, and then excising the flaps of skin on each side.

Dr. Huc, of Rouen, divides the prepuce by passing an *elastic ligature* through its dorsal surface by means of a large needle; the elastic cord cuts its way out in three or four days. Circumcision has also been performed with an elastic ligature. This method is tedious, painful, and more dangerous than ordinary circumcision. In some cases the ordinary or the galvanic *écraseur* has been used, but the wound left is a highly contused one, and is liable to be followed by suppuration and secondary hemorrhage.

Circumcision performed in the following manner will give good results. Having marked the situation of the base of the glans penis on the foreskin, the surgeon seizes the prepuce with a pair of catch-forceps, at the junction of the skin and mucous membrane, draws it well forward, grasps it firmly with a phimosis-clamp or pair of dressing forceps, slanting the instrument downwards and forwards so as to leave the frænum as long as possible, and removes the portion in front of the clamp with a straight bistoury. On removing the clamp, the skin will slip back towards the base of the glans, leaving it covered by the mucous membrane as with a cap; this is to be slit up in the middle line, above, as far as the corona glandis. The vessels which are found on the dorsum, and at the frænum, are to be twisted or tied with fine catgut. The mucous membrane is to be stitched carefully to the skin by the requisite number of fine catgut sutures, which in the course of a few days will become absorbed; or a continuous silk suture may be used, beginning at one side of the frænum and ending on the other, the ends being fastened together so that when it is necessary to remove the suture, it will come away when one portion is cut and traction made on the ends. The parts heal so very rapidly in children that with them it is unnecessary to introduce sutures. It is advisable to give children an anæsthetic, but in adult cases it is better, when no adhesions are present, to freeze the part in front of the clamp with a freezing mixture or ether spray. The patient must rest in bed with a narrow strip of lint wrapped around the part, which is to be supported against the abdomen. In some cases the operation is rendered more severe from the adhesion of the prepuce to the glans; the parts are to be separated by tearing the adhesions down, or by dissection. Sir William Fergusson recommended the removal of the entire foreskin in these cases. Adults suffer inconvenience from erections, which cause a drag on the sutures, and which are best prevented by using a hard bed with light covering, and by applying an India-rubber bag filled with ice between the legs. If the operation be performed in the manner here advocated, too much skin cannot be removed. It has happened that the prepuce has been drawn so far forward that a circle of skin has been removed from the body of the penis; it is then necessary to slit up the mucous membrane and stitch it to the skin which remains. If too little of the foreskin be taken away, it will contract on cicatrizing; enough must be removed to uncover the glans. The end of the glans penis may be cut if the operation is done without a clamp.

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[1] Am. Journ. Syph. and Derm., Oct. 1872.

Some surgeons circumcise by slitting up the foreskin on a director, then seizing the angles and trimming off the rest of the prepuce. When the parts are very œdematous, care must be taken not to pass the director into the urethra, but under the upper part of the prepuce, where it is made to project. A sharp-pointed may be converted into a blunt-pointed bistoury by placing on its point a small piece of beeswax, which will be left behind when the point of the knife is thrust through the tissues.

Professor Humphry[1] removes the entire foreskin in cases of congenital phimosis. A circular incision is made through the skin on a level with the corona glandis, and the prepuce, having been slit up, is removed with scissors just in front of its attachment to the base of the glans. The cut edges of skin and mucous membrane are sewn together, but no dressings of any kind are employed; the patient is kept in bed, and if suppuration comes on a poultice or water-dressing is applied. The frænum ought to be divided when it is abnormally short, and also if it is the seat of a small chancroid, which is apt to ulcerate into the artery of the part, and cause bleeding at an inconvenient time. Mr. Howse also advocates removal of the frænum when performing circumcision, to prevent the œdema and chronic swelling which sometimes follow. Silver-wire sutures are not as readily manipulated as those of silk or catgut, and are more apt to catch in the dressings. The serre-fines of Vidal, which are used in France, are as painful and not as secure as stitches.

The contra-indications to operative interference are few: cases of hemorrhagic tendency had better be let alone, or, if necessary, the part may be removed slowly with the galvanic écraseur. An operation should not be recommended unless the patient were in a good state of health, free from albuminuria or diabetes, and with healthy surroundings.

Paraphimosis is the condition brought about when a tight or contracted foreskin is drawn above the glans penis, and when, owing to the rapid swelling of the glans and prepuce, the patient is unable to draw the latter down again. If seen at once, reduction can be readily effected, but if neglected, the swelling increases and is attended with much pain. On examination, the glans penis is found to be swollen and red; the foreskin is very œdematous, and forms a collar around the glans, on depressing which the tight foreskin may be seen in the sulcus between the œdematous collar and a second one formed by the swollen tissues which cover the body of the penis.

Treatment.—The parts may, as a rule, with a little force and perseverance on the part of the surgeon, and stoicism on the part of the patient, be reduced to their natural condition. First oil the parts in front of the constriction, then wrap around them a piece of lint and pass the two forefingers above, and the two middle fingers below the penis, embracing it tightly; the two thumbs then press forcibly on the glans penis so as to reduce its bulk by pressing out the blood, and at the same time the fingers are drawn forcibly forwards, when, after a few minutes, the glans will recede and the foreskin advance to its proper place. When the parts are œdematous, reduction will be facilitated by puncturing the tissues with a needle and bathing them with hot water. Ice may also be used to reduce the volume of the swelling.

Another mode of reduction (Mauriac's) is to grasp the penis with the left hand, compress the glans, and slip the right index finger beneath the constriction, between it and the dorsum of the penis, then working the swelled foreskin, which is between the glans and the sulcus, backwards, under the stricture, and drawing at the same time the constricting foreskin forwards. M. Mercier reduces a paraphimosis by grasping the penis with the left hand, and by placing the right index and middle fingers longitudinally along the lower surface of the organ ; the pulp of the thumb presses against the glans, pushes backwards the œdematous fold of the mucous membrane, and guides it under the stricture by means of the thumb-nail ; the left hand draws forwards the prepuce at the same time.

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[1] Holmes's System of Surgery, 2d edit., vol. v. p. 179.

It will be observed that the constriction is caused by the tight orifice of the foreskin, and that the sulcus is well marked above and deficient below ; and if it be found necessary to divide the band at the bottom of the hollow, before reduction can be accomplished, this can be readily done by dividing the constricting prepuce ; the small cut will instantly gape, and if the part have not been displaced long enough for effusion to have taken place, matting the parts together, reduction will be readily accomplished. If not relieved, ulceration and a good deal of thickening and distortion will ensue, and recovery be retarded. The accident, which has sometimes happened to an unfortunate man on his wedding tour, is likely to be repeated, and it is therefore well to slit up, or better still circumcise, the foreskin, and so prevent the recurrence of the annoyance. In weak subjects sloughing may take place rapidly, or ulceration may ensue in front of the stricture ; but as a rule the stricture itself gives way by ulceration. After the reduction of the paraphimosis the patient should remain in bed, and should apply water-dressing or lead-lotion to the part.

When paraphimosis from neglect has become chronic, and the tissues are ulcerated and indurated, there is no fear of strangulation, and the parts, owing to the induration, are not readily reduced ; it will then only be necessary to divide the stricture. Paraphimosis without strangulation may be treated by compressing the penis with strips of plaster, applied longitudinally and circumferentially. The condition of the glans penis may be judged of by its color : in the normal state it is red when compressed, the color going and coming under pressure of the finger, but when there is strangulation it is dark-colored and cold, and loses its sensibility.

It may be desirable, in cases of tight paraphimosis, to administer an anæsthetic, as reduction is a painful proceeding.

TUMORS OF THE PENIS.— *Vascular tumors* are formed when a rupture of a vessel or of the body of the penis takes place. True *aneurisms* are not met with, but it is possible for a false aneurism to form after an injury to an artery. In cases of cancer of the penis the *veins* may become enlarged and tortuous, but varicose veins are not met with on the penis. The *lymphatics* may inflame on the dorsum of the penis, after excessive sexual indulgence, or after inflammation set up by any irritating cause. Red lines may be seen running along the surface of the organ, and hard cords may be felt terminating in a gland at its base.

Serous, sebaceous, and blood cysts are found in connection with the penis, the most common variety being the sebaceous cyst.

A serous cyst removed by myself from the lower part of an adult's prepuce, was as large as a marble, and transparent, and is preserved in the Anatomical Museum at King's College. A similar cyst, only much larger, was removed by the late Sir William Fergusson and presented to the Hunterian Museum. (No. 2590 A.) The cysts are readily dissected out from the cellular tissue, and the edges of the incision are brought together with fine catgut or silk sutures.

Fibroid Tumors of Penis.—Mr. Henry Smith drew my attention, a short time back, to the case of a middle-aged patient who had, on the dorsum of the penis, at its point of attachment to the pubes, a saddle-shaped deposit extending rather less than an inch from before backwards, and the same from side to side:—

> It was in the substance of the penis, beneath its fibrous sheath, and permitted the fingers to be passed just under its lateral portions, but not under it either in front or behind. There was no distinct history of syphilis; the patient seemed in good health, was free from gout, and had a number of healthy children. On erection, the penis curved a little at its base, but connection was not prevented. The mass was hard, and felt like a small saddle of cartilage.

In some cases the deposits are said to be multiple and to resemble ganglia; they cause a painful curvature of the penis on erection, and a difficulty in micturition when the corpus spongiosum is affected; the skin is not altered in any way, and glides freely over the deposit. The change probably is due to plastic effusion into the trabecular tissue of the penis, which prevents the equable distention of the cells when erection takes place. Van Buren, from cases observed by himself, says that the prognosis is favorable, as the induration does not spread, and is not followed by degeneration or disorganization. Blisters, mercury, and iodide of potassium have been tried without effect in these cases; a constant current of electricity has been recommended. Gummy tumors remain stationary, resolve, or soften down, and respond to constitutional treatment. In one of Van Buren's cases, the induration travelled from before backwards to the root of the penis, and the curvature of the penis when erect became less, rendering intercourse more satisfactory. In some cases there is a history of injury. Ricord says that the change is due to an old phlebitis, to a slight rupture of one of the cavernous bodies of the penis, or to constitutional syphilis. It has also been attributed by Sir P. Hewett to thrombosis occurring in a gouty subject. To whatever cause due, time is an important element in the treatment.

The pathological museum at Vienna possesses a remarkable specimen of *ossific deposit* in the substance of a penis; these cases are very rare indeed.

Elephantiasis of the penis is generally associated with elephantiasis of the scrotum, and in these cases the penis may attain to a large size; in others it seems to be lost in the scrotal swelling, its place being marked by a depression like an umbilicus. In operations on elephantiasis scroti, the penis is to be preserved under any circumstances, but Sir Joseph Fayrer recommends that, as the skin is likely to be diseased, none shall be retained to cover the organ. Elephantiasis of the penis prevents sexual intercourse, but the ability is recovered after operation. The etiology and treatment of these cases are considered in another portion of this article.

Warts or vegetations are often associated with gonorrhœa, and are found lining the prepuce, or in the furrow between it and the glans penis; if not interfered with, they grow luxuriantly, spreading over the surface of the glans penis, and invading even the orifice of the urethra; they are attended with a foul discharge and cause phimosis. Small warts may be readily removed with scissors, the bleeding points being touched with solid nitrate of silver. In more formidable cases the patient should have an anæsthetic, or the warts may be frozen with ether-spray if the patient desire it, and may then be shaved off with a knife, the bleeding, which is free, being stopped by the actual cautery or the strong liquor ferri perchloridi. The growth, if preferred, may be removed by the galvanic écraseur or by caustics, those in common use for this purpose being the acid nitrate of mercury, fuming nitric acid, and glacial acetic acid; the strongest and most painful is chromic acid. It is desirable when practicable, before removing the warts, to apply to them for some time the strong liquor plumbi, which will cause them to turn white, shrivel up, and become brittle, when they can be more easily and thoroughly removed; the parts after removal of the warts must be kept dry, and nitrate of silver should be applied if they show a tendency to return. Hemorrhage during the performance of the operation may be controlled, and the removal of the growths rendered easier and more certain, by tying a piece of ordinary elastic tubing around the base of the penis. When the warts are removed, the surface of the glans will appear unindurated and healthy, and its cut surface will speedily granulate and heal. These vegetations are not venereal, and may be in some instances got rid of by observing extreme cleanliness, and by painting them with corrosive sublimate dissolved in collodion, in the proportion of a drachm to an ounce, or by dusting them with calomel. The growth in some cases is so extensive that the foreskin cannot be drawn back, and under these circumstances it is necessary to slit it up and remove the warts without delay. The growth is a papilloma due to an excessive development of the papillæ. The condylomata due to a gonorrhœal discharge are broad or pointed. Warts on the penis, as elsewhere, occasionally enlarge and become covered with hard, dry, epidermic material, forming horns. Excision is the proper treatment.

Carcinoma attacks the genital organs, usually assuming the form of *epithelioma;* the other kinds are rarely met with. Epithelioma may invade the prepuce, or the whole penis, or any part of it. The most common age for its occurrence is fifty years or over. In the great majority of cases there has existed a congenital or acquired phimosis prior to the advent of the disease. A contusion or a urinary fistula may be the exciting cause. With a phimosis, the parts are not kept clean, but the gland is macerated and rendered tender and excoriated by retained secretions, and the irritation causes an epithelioma to grow, in those predisposed to the disease, as is found to be the case when the tongue is irritated by a broken tooth, or the scrotum by the presence of soot in its folds. Syphilis has no direct influence in inducing the disease, but a syphilitic chap or ulcer may be the starting-point of an epithelioma. Two kinds of epithelioma affect the penis, the indurated variety and the vegetating or cauliflower-like growth.

The growth of an epithelioma of the penis resembles its growth elsewhere. A tubercle forms, becomes indurated, slowly increases in size, and eventually becomes painful. The growth may spread superficially, or may remain comparatively stationary on the surface but extend into the deep tissues. The nature of the disease, in either the prepuce or the glans, is masked by a phimosis. Thiersch has applied the term *superficial or flat epithelial cancer* to those cases which affect the surface of the skin, and *infiltrating epithelial cancer* to those which rapidly penetrate into the deeper parts. The surface of the nodule may remain hard, or its centre may ulcerate, giving rise to a deeply excavated ulcer with indurated edges. Instead of commencing as a nodule, the carcinoma may start as an indurated papilloma or wart, assuming a fungating appearance and invading the tissues at its base. The discharge is offensive and ichorous. The growth does not extend along the skin of the penis, but surrounds for a time, and eventually invades, the corpora cavernosa or the corpus spongiosum. When the ulcerating form of the disease attacks the prepuce, it destroys the mucous membrane, and presents an excavated and uneven surface, with indurated, sharp-cut edges.

A man was admitted into King's College Hospital for retention of urine due to an indurated condition of the penis. The anterior fourth of the organ was enlarged and of a stony hardness, the glans being nodular, but not fungating. The hardness and the general appearance were such that it was uncertain, until a microscopic examination had been made, whether the case was one of epithelioma or one of scirrhus. The penis was amputated, and was interesting as a specimen, as the disease (epithelioma) had evidently invaded the corpus spongiosum, which was much thickened, and had spared the corpora cavernosa.

The *prognosis* in these cases is much more hopeful than in epithelioma in other situations, and cases are recorded in which patients thus affected have lived for many years. Sir Wm. Lawrence operated on a patient who was quite well twelve years afterwards, and Sir Wm. Fergusson amputated the penis of a man of note in the political world, who lived many years after the operation and died at an advanced age. I assisted Mr. Henry Smith, on two occasions, to remove from the glans and from just below the urethra of a gentleman, some vegetations of a cancerous appearance. The growths recurred after the first operation, but not after the second, which was performed more than ten years ago. I was not so fortunate myself in a case at King's College Hospital:—

A respectable-looking, married man applied with a phimosis attended with an offensive discharge, and induration of the glans penis. As the case got worse under the application of lotions, instead of better, I slit up the foreskin and discovered that the glans penis was covered with vegetations of a suspicious appearance. I admitted him into the hospital, intending to remove his penis, but the late Sir Wm. Fergusson, who kindly saw the case in consultation with me, advised the removal of the growths. I removed the tumors, cutting well into the surface from which they grew. The man was in due course discharged from the hospital, but soon reappeared, with a few of the growths which had returned in the old situation. These were kept in check by means of caustics, but the inguinal glands enlarged with great rapidity, the skin ulcerated, and a fungus hæmatodes resulted and soon destroyed the patient. This case, which seemed a favorable one for operation as far as the local disease was concerned, was rapidly fatal owing to the glandular affection.

It is necessary to examine the case carefully before deciding upon an operation, as in some instances the tumors can be removed, whereas, in others amputation must be done. When the prepuce alone is involved, it must be freely removed. In these cases the nearest inguinal glands become affected only after the disease has existed for some time, and metastatic formations are rarely found in the internal organs. In some instances the disease does not extend readily through the tough fibrous tissue which forms the sheath of the corpora cavernosa, but in others the trabecular tissue is extensively invaded. The operation is a hopeful one, because the whole of the disease can be effectually removed. In some cases, however, although the site of the operation remains sound, the inguinal glands may become diseased. The patient then becomes cachectic, and dies worn out by pain, hemorrhage, and the constant discharge.

Epithelioma of the penis has to be distinguished from induration due to syphilis, and from non-malignant vegetations. The appearance and history of the patient will often help the surgeon: the man may be a married, middle-aged, respectable-looking man, denying that he has been exposed to contagion, although the nature of the case and the operation necessary for its cure be put clearly before him. In doubtful cases, local and constitutional remedies must be carefully tried before the knife is resorted to. In simple vegetations the surface of the glans is of its normal color, smooth, and not indurated; and when the warts are removed, the cut surfaces granulate healthily, remain smooth, and heal soundly. In malignant cases the pain is sharp and the general health suffers, and the importance of an early operation is obvious. The base of the growths is hard, and the discharge is very offensive.

In epithelioma the growth is *in the tissues*, which it invades, whereas in non-malignant vegetations it is *on the surface*, from which it may be readily shaved off with a knife. Before operation, a portion of the growth should be removed and submitted to microscopic examination.

AMPUTATION OF THE PENIS.—Of this operation, Sir William Fergusson[1] writes that he knows of no amputation which has been more successful in its primary results, but that in general, in cancerous-looking affections, the disease has returned, either in the organ, or more frequently in the glands of the groin, and has ultimately destroyed the patient; and further, that if certain sores which may be termed pseudo-cancerous, were treated by excision at an early date, instead of by improperly directed constitutional means, there would be a better account of these diseases of the penis than surgery can at present boast of. He had seen admirable results from excisions—longitudinal amputations as they might be called—of the glans penis.

Mr. A. Pearce Gould[2] amputated the penis of a man, aged 75, for melanotic epithelioma, a very rare condition, which had first appeared five years before. Four or five raised black nodules, the size of peas, were ranged along the corona, while further forward on the dorsum of the glans was a much larger, black, fungating mass, which quite obscured the part. Two or three smaller tumors of the same color were seen higher up the penis, not projecting from the surface. No glandular enlargement could be detected. A few deeply pigmented warts and molluscous growths were scattered over his back; these were congenital. Under the microscope, the superficial epithelium could be traced growing downward, and becoming pigmented and continuous with the tissue of the deeper parts of the tumor.

In Mr. Marcus Beck's case of fibrous tumor of the penis, the growth, which recurred two years after it had been removed, sprang from the corpus cavernosum and necessitated amputation of the penis. It was as large as a fowl's egg, irregular, nodular, very hard, and free from pain. A microscopic section showed numerous oval nuclei.

Amputation by Ligature.—Amputation has been proposed and practised by tying a silk cord around the penis, at the spot selected for its removal, behind the disease. The ligature is tightened from time to time as it cuts through the tissue and becomes loose. This operation is tedious and painful, and is attended with suppuration and the presence of a sloughing mass which is likely to cause purulent infection. Hemorrhage is prevented, but there is a danger of cystitis.

Amputation by the Écraseur.—A sound having been passed into the bladder, the wire of the écraseur is fixed in place by passing it behind a needle thrust through the body of the penis. The instrument is worked slowly, and is made to cut its way through. The strong fibrous sheath of the penis prevents the wire from cutting very readily.

Amputation by the Actual or Galvanic Cautery.—M. Bonnet, of Lyons, amputates the penis by means of *actual cauteries* of suitable shapes. He marks the penis at the point selected for operation, and divides it by means of the cauteries, which burn their way slowly. There is no bleeding, as the vessels are sealed as they are divided by the hot iron. No cystitis or retention of urine follows the operation. The lower border of the urethra is divided in the usual way at the time of the amputation, or subsequently, to prevent its contraction. Paquelin's thermo-cautery is at once an elegant and efficient instrument for the performance of the above operation.

The *galvanic écraseur* may be used to divide the penis. The platinum wire is passed around the penis behind a stout needle thrust through its body.

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[1] System of Practical Surgery, 5th ed., p. 680.

[2] Proceedings of the Medical Society of London, vol. v. p. 88. 1881.

The end of the instrument pressing against the side of the penis, connection is made with a battery, the wire becomes red hot, and, as it burns its way through the part, its loop is tightened. Mr. Erichsen[1] uses the galvanic écraseur with great success in the removal of the penis, which is effected without loss of blood. A full-sized catheter without rings is first passed into the bladder, and is retained there during and after the operation. A narrow tape is then tied around the root of the penis, to compress the vessels and to steady the skin. The wire of the écraseur is next slipped over the organ behind the disease, and is worked until the tissues are divided through to the catheter. The separated portion of the penis is then slipped off over the catheter, which is tied in. By performing the operation in this manner the difficulty of finding the orifice of the urethra in the burnt mass is obviated, and the tendency of the orifice to contract is prevented by the retention of the catheter during cicatrization.

Amputation by the Knife.—Before amputating the penis, all hair should be shaved from the part. Some surgeons remove the skin by drawing it forward, whilst others preserve it in order to form a hood for the stump formed by the corpora cavernosa; if too much be left, it impedes the free escape of the urine and causes irritation. A tape or elastic cord is to be tied around the base of the penis to prevent hemorrhage and to fix the skin. The penis is to be put on the stretch with the surgeon's left hand, and removed with one stroke of a catlin, taking care to cut free of the disease. The vessels—which are found, two in the dorsum, one in each corpus cavernosum, and one in the septum—are to be tied, as also any bleeding point. The cut orifice of the urethra, which is readily seen, is seized with a pair of forceps, its lower or free wall is slit downwards with a pair of scissors or knife, for about half an inch, and the cut margins of the mucous membrane are stitched to those of the skin, to prevent subsequent contraction of the urethral orifice. Sir William Fergusson amputated a penis by drawing it forward and removing it with one stroke of the bistoury, an assistant steadying the skin and compressing the base of the organ with his fingers. All bleeding vessels were then tied, and the lower wall of the urethra was slit up and stitched carefully to the skin. Some surgeons recommend that the corpus spongiosum should be cut long, either before or after the section of the corpora cavernosa, and left to project like a spout. When the penis is divided far back, under the pubis, in order to obviate hemorrhage, troublesome to control owing to the retraction of the stump, it has been recommended to divide the penis from above downwards to the corpus spongiosum, and not to divide this last structure until the vessels have been all secured. Others securely fix the penis by passing a stout ligature or harelip pin through its body prior to its division.

The operation is done easily and with little loss of blood by clamping the penis at its base with Mr. Henry Smith's hemorrhoidal clamp, which is provided with a screw. The penis is removed at the point selected; the vessels, which are readily seen, are ligatured; the pressure of the clamp is partly relaxed by slightly unscrewing it; any bleeding point is tied; the lower wall of the urethra and the skin are divided, and their cut margins are brought together with sutures. Mr. Erichsen describes an operation for the removal of the penis, done by passing a full-sized gum-elastic catheter into the bladder, where it is retained during and after the operation; a narrow tape is tied around the base of the penis, which is then amputated behind the diseased part by cutting through the catheter at the same time that the organ is divided. In some instances Professor Humphry cuts the urethra longer than the stump of the penis, and, having perforated the skin of the perineum, passes the spout-like urethra through the cut, from which it projects for about half an inch. In others he makes a circular incision through the skin behind the part to be removed, and reflects the skin for about half an inch; he then cuts through the spongy body on the level of the first incision, dissects it up from the corpora cavernosa for half an inch, and divides them at this latter point. The reflected skin is united over the cut ends of the cavernous bodies, which it covers like a cap, leaving the spongy body and urethra projecting a quarter of an inch or more beyond the surface of the wound. It remains slightly projecting, and with a freely open aperture, after the wound has closed.[1] Sir Joseph Lister makes skin flaps and dresses the stump of the penis and the urethra separately with boracic lint. The patient, when he urinates, removes the dressing from the urethral orifice, which he cleanses with boracic lotion.

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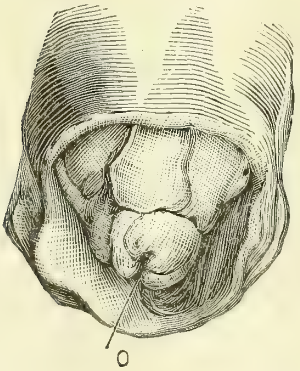
[1] Science and Art of Surgery, 7th ed., vol. ii. p. 939.

Of late, very extensive operations have been undertaken for the removal of the penis when infiltrated with epithelioma. Mr. Pearce Gould and others have divided the scrotum, and dissected away by means of a scalpel and a raspatory the crura of the penis from the pelvic bones; the enlarged inguinal glands have been removed at the same time.

An ordinary case of amputation of the penis is the simplest amputation that the surgeon is called upon to perform. With regard to hemorrhage, the vessels spurt briskly, but are soon seized, and any trouble from retraction of the cut corpora cavernosa within the folds of skin is obviated by the different expedients already explained.

Fig. 1358.



An old case of amputation of the penis; on the face of the stump is seen the patent urethral orifice.

The best treatment of the divided urethra is a problem of great interest. When the urethra was simply divided across, it contracted so much when it cicatrized that a formidable stricture was produced. When called to a case of retention of urine caused by one of these strictures, the surgeon finds considerable difficulty in determining the exact situation of the orifice of the urethra, the parts are so swollen and tuberculated from the irritation caused by the dribbling of urine.

Smyly united the mucous membrane of the divided urethra to the skin. Earle, of St. Bartholomew's Hospital, incised the mucous membrane of the canal, leaving the skin intact. Mr. Teale, of Leeds, recommended the division of the mucous membrane and skin at the posterior wall of the urethra, and the union of their cut edges by sutures. This plan of treatment has been attended with great success. Demarquay, who studied this subject carefully, recommended that the urethra, with the corpus spongiosum, should be cut longer than the corpora cavernosa, and should be divided at its anterior and posterior walls, the divided portions being turned outwards and stitched to the margins of the skin. Some surgeons perform a perineal section behind the point at which the urethra is divided.

After amputation of the penis, the patient passes his urine downwards between his legs, and ought to be provided with a small funnel to carry it away from his person.

[1] Holmes's System of Surgery, 2d edit., vol. v. p. 181.

Affections of the Scrotum.

Contusions and Wounds of the Scrotum.—When the scrotum is *contused*, there is extensive extravasation of blood and much discoloration, the tissues becoming black and blue. The application of an evaporating lotion, a bag of ice, or a cold-water coil, is generally successful in removing the effusion. Suppuration rarely follows extravasation of blood, but when it does, exit must be given to the pus by incisions. In *wounds* of the scrotum the testicle may protrude; it is then to be returned, the wound being enlarged if necessary, and the divided parts brought together by harelip pins or sutures. The wounds heal readily, as the parts are vascular.

Cutaneous Eruptions.—The different kinds of *prurigo* attack the scrotum, and cause great annoyance and want of rest when the patient becomes warm in bed. Small red papules appear on the scrotum, and, owing to the injury to the skin done by the nails in scratching, the parts become scarred and deeply pigmented as in other regions of the body. A great many remedies have been tried for the cure of the disease, such as tonics by day and sedatives at night to procure sleep, with lotions containing perchloride of mercury, sulphur, creasote, vinegar, lime-water, or prussic acid, and ointments of aconitia or tar. Dr. Bowling, of Kentucky, recommends that the affected parts should be sponged for a minute or so with good apple vinegar, and when dry smeared over with the unguentum hydrargyri nitratis. Various kinds of baths are at times useful. *Diabetes* sometimes leads to an irritable condition of the scrotum. The skin of the scrotum is normally, in some cases, deeply pigmented, and may have scattered here and there on its surface *white patches*. *Pediculi* cause a good deal of irritation, and may be seen as black specks attached to the roots of the hairs; their eggs also are very obvious. Any of the mercurial preparations will soon destroy them.

Œdema of the Scrotum.—Œdema, commencing at the bottom of the scrotum, is met with in cases of dropsy. Both sides of the scrotum are affected, becoming much swollen, with a waxy, smooth, transparent look; the part feels thick and doughy, and pits when squeezed between the fingers. The testicles cannot be readily felt. The cellular tissue of the penis is also distended in cases of general anasarca, and the foreskin is contorted and projects beyond the glans which is hidden; at times, the foreskin having been drawn back incautiously, a paraphimosis results. There will be œdema of the legs and other symptoms of visceral disease. A temporary œdema may be caused by the rupture of a hydrocele or its treatment by acupuncture, which in turn, or the introduction of one or more of Dr. Southey's trocars, will suffice to relieve the distention if interference be deemed advisable. Œdema of the scrotum, or *anasarcous hydrocele*, as it has been called, may occur without the presence of œdema in other parts. A slight excoriation of the skin may be followed by inflammation, which generally subsides under the application of starch-powder or fuller's earth, but in some cases erysipelas comes on, the part swells, becomes very œdematous, and may finally slough extensively. It must be remembered that œdema is a valuable indication of deep-seated suppuration, and that pain, heat, redness, and swelling of the scrotum may be due to an acute suppuration of the tunica vaginalis, a condition possibly at times overlooked—the cause of death being assigned to erysipelas or to some other more or less superficial inflammation of the part.[1]

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[1] Lancet, vol. i. p. 863. 1883.

Cases of diffuse inflammation of the scrotum were described by Mr. Liston[1] as *acute anasarca* of the scrotum. Some mild cases are met with in adults, in which the skin is pinkish, shiny, tense and œdematous; there is slight fever. The redness and swelling also affect to some extent the penis and groin. Most of the patients are in a debilitated state of health. In some cases, slight abrasions, sores, or eruptions situated in the groins, genitals, or insides of the thighs, or fistulæ about the perineum or anus, take on a violent, erysipelatous, inflammatory action; pus is formed, which, instead of becoming circumscribed and forming an abscess, is diffused throughout the cellular tissue of the scrotum, penis, and groins; the constitutional and local symptoms are very acute, the patient being attacked with nausea and vomiting, and having a quick pulse and high temperature; locally the parts are painful, red, shining, and œdematous, and the rugæ of the scrotum are quite obliterated. The swelling, which is great, passes into the penis and abdomen; the perineum will be free from swelling when no extravasation of urine has taken place, and a full-sized catheter can be passed. When extravasation of urine is present, much the same symptoms will be noted, but there will be, in addition, a brawny swelling in the perineum, and a history of injury, or of stricture—such as difficulty in passing water, or retention of urine—when a catheter will demonstrate the locality of the lesion. In young children a stone may be impacted in the urethra, and give rise to irritation, retention of urine, and an abscess in the perineum with scrotal œdema. A sound will generally detect the stone, which must then be removed; but when sloughing has taken place, the stone may slip into a pocket and elude the instrument.

MORTIFICATION OF THE SCROTUM is most frequently caused by extravasation of urine following an injury to the penis or urethra, or from ulceration of the urethra due to a stricture or to an impacted calculus ulcerating its way out to the surface. Mortification is a sequel of diffuse cellulitis, when severe, and is liable to follow in patients debilitated by exhausting illnesses. The symptoms of diffuse inflammation become exaggerated, the parts becoming livid and violet-colored, and covered with ash-colored spots which are associated with an ill-smelling discharge. The scrotum but very rarely suffers from mortification caused by a frost-bite, but there is in the Anatomical Museum of St. Thomas's Hospital a cast (No. 116) of a testis exposed by the sloughing of the scrotum after this accident; the penis was much swollen, as its absorbents were divided by ulceration. Mr. Curling has only met with one instance of frost-bite of the scrotum; the case was not a severe one; the patches of mortification were small and soon healed up. The most important point in the treatment of the cases we have been considering is to make early and free incisions into the affected tissues. The patient is to be confined to bed, the affected parts being kept well elevated. If the case is a bad one, a water-bed, to prevent bedsores, is most desirable. Carbonate of ammonium, bark, beef-tea, milk, eggs, brandy, etc., are to be given freely. Locally, the parts are to be fomented and poulticed; disinfectants, such as charcoal, carbolic acid, salicylic acid, iodoform, chloride of zinc, etc., are to be freely used; and sloughs are to be removed as soon as possible. At a later stage of the case, stimulating lotions and ointments, and nitrate of silver, will be found useful. The testicles become satisfactorily covered when denuded of their envelopes by laceration of the integuments, or after their loss by sloughing.

Mr. Alexander Edwards[2] met with a case in which the whole testicle protruded through an opening which followed a scrotal abscess. The testicle was returned, a cavity having been made for its reception in the scrotum, which was brought over the gland with harelip pins after the edges of the opening had been pared.

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[1] Med.-Chir. Trans., vol. xxii. p. 288.

[2] Edin. Med. Journ., November, 1860.

PNEUMATOCELE OF THE SCROTUM.—If the swelling be caused artificially by the introduction of air for the purpose of deception, there will be the crepitation which is so characteristic of surgical emphysema.

SYPHILITIC INDURATION.—In some cases of tertiary sores on the genitals, there is thickening of the scrotum and penis, which yields to constitutional and suitable local treatment.

ELEPHANTIASIS OF THE SCROTUM is met with in two forms: The first variety is due to hypertrophy of the tissues, but in the second kind the lymphatics and lymph spaces play the more prominent part, and to this the name of "lymph-varix" has been applied by Dr. Carter, that of "nævoid elephantiasis" by Sir Joseph Fayrer, and that of "lymph-scrotum" by Dr. Manson. The following cases are reported by Sir Joseph Fayrer:—[1]

A native of India, aged 25, presented a tumor which was of three years' growth, and which had been associated with attacks of fever, once or twice a month, attended by a copious secretion of lymph which was discharged freely when the skin was removed by scratching. The tumor was of the nævoid variety and weighed eleven ounces.

An Indian, aged 30, suffered from the ordinary or firm hypertrophy of the scrotum, the tumor weighing $3\frac{1}{4}$ pounds and being of two years' growth. Both patients recovered rapidly after operations performed bloodlessly. No filariæ were discovered.

Elephantiasis is non-contagious; it is endemic in intertropical localities near the sea-coast, where malarial diseases are prevalent, its geographical distribution being coincident with that of the mosquito (Manson). It is met with in different members of the same family, and is common between the ages of twenty and forty, but rare in infancy and old age. No race exposed to its predisposing causes is exempt, and it attacks men three and a half times as often as women, and dark more often than fair races. An attack of scrotal elephantiasis is ushered in by severe constitutional and local symptoms: the temperature is exalted; there is intense pain in the lumbar region, in the groin, and in the testes, which become swollen; the swelling of the spermatic cords dilates the inguinal canals, predisposing to the herniæ which are often met with in these cases. Hydroceles form, often of a large size. The surface of the integument becomes inflamed, and if the secretion of lymph be excessive, it exudes freely; at other times there is a temporary herpetic condition attended with an acrid and offensive serous exudation. The attacks of fever recur, and are attended with exudation, which leaves the parts enlarged after each attack. When these have attained a large size the febrile disturbance is lessened, and the patient, as a rule, enjoys fair health in the intervals between the attacks; but sometimes the malarious influences to which he is exposed give rise to diseases of the liver or spleen, which, combined with the pain and inconvenience of the local malady, debilitate the patient to the last degree. The appearances presented by the disease are characteristic: the tissues of the scrotum are very heavy and much thickened, and in a rugose condition. When the skin of the penis is affected that organ becomes much enlarged; at other times it disappears within the mass, its position being marked by a depression like an umbilicus. Owing to the local conditions and the debility caused by the disease, the patient's procreative power is in abeyance, but is restored after the removal of the mass. The tumors vary in weight from a few ounces to over one hundred pounds. The operation for the removal of these enormous tumors has been very successful: at the Medical College Hospital, Calcutta, out of 193 cases, 158 recovered and 35 proved fatal. Richards gives the average duration of life as eleven and a half years, and says that the affection has little tendency to shorten life when unassociated with visceral disease.

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[1] Tropical Dysentery, etc. London, 1881; Trans. Path. Soc. Lond., vol. xxx. 1879.

Microscopical Appearances.—I am indebted to Dr. Heneage Gibbes, whose name is well known in connection with his researches on the Bacillus of Tubercle, and other work, for the microscopic sections which have furnished the illustrations (Plate XXXIV., Figs. 3 and 4), and which were obtained from a large specimen of elephantiasis scroti in King's College Museum.

The first section shows under the microscope, at the spot selected for demonstration, papillæ running up to the surface of the section and infiltrated with small cells, which resemble leucocytes, and which are deeply stained with logwood. The normal connective tissue of the cutis vera appears to have been separated into small fibres by the action of fluid. In spaces between the bundles are a number of oval cells, like small leucocytes, which are probably plasma-cells. Deeper in the cutis there is enormous hypertrophy of the muscular tissue. The bundles run in every direction; many of them are cut across transversely, and are seen to be surrounded by fibrous connective tissue. This portion of the tumor is very vascular, being abundantly supplied with capillary bloodvessels. The lymphatics appear to be normal in structure, but are larger than usual. Throughout the section are to be seen aggregations of small cells, very deeply stained, forming lymphoid tissue.

The second preparation is made to show the deeper part of the tumor, which consists for the most part of fibrous tissue, separated by the action of fluid into small fibres. Here and there are a few masses of lymphoid tissue and bundles of unstriped muscular fibres. The small arteries are seen associated with these lymphoid masses. Here and there are larger bundles, which are stained more deeply and might be taken for filariæ. In the intestines are a large number of cells, many of which are probably plasma-cells.

Dr. Thin,[1] in a case of elephantiasis of the penis, found under the microscope no appearance of a multiplication of cells by division, and infers that the whole of the cells present are derived from the white corpuscles of the blood.

Of late years, Manson, Lewis, and Bancroft have done most valuable work in pointing out that these cases, if not caused by, are frequently associated with, the presence of a parasite, the "filaria sanguinis hominis."

Embryo filariæ were discovered by Dr. Wucherer (Bahia), in the urine from a case of hæmato-chyluria, in 1866; in the blood, in 1872, by Dr. Lewis (India), who gave them the name of "filaria sanguinis hominis." Dr. Manson (China) made the important discovery that the filaria's intermediary host was the mosquito, and described the periodicity of filarial migration.[2] Dr. Bancroft (Australia) was fortunate enough to discover an adult filaria with microscopic progeny (Dec. 21, 1876). On March 22, 1877, he removed from a hydrocele, by tapping, four adult worms which moved freely in the hydrocele fluid, but became quiescent in water. Dr. Cobbold[3] gave a description and drawings of the worm, and called it "*Filaria Bancrofti*" out of compliment to its discoverer. Dr. Lewis[4] found an adult worm in a scrotal tumor which he had amputated. Dr. Bancroft has suggested the injection of water into the tumor, or the application of electricity, as a method of treatment. He found filariæ present in five cases of orchitis; in four cases of hydrocele, one of which contained chylous fluid; in one case of varicocele; and in one case of commencing elephantiasis scroti. The embryo is inclosed within a tubular sheath, within which it elongates and shortens itself; its diameter is about that of a red blood-corpuscle, being $\frac{1}{3500}$ inch, and its length $\frac{1}{75}$ inch. Its movements are rapid. The female is from 2 to 3 inches long, and reproductive organs can be distinguished. The ova are oval, $\frac{1}{500}$ x $\frac{1}{750}$ inch in size, and when crushed give exit to inactive embryos.

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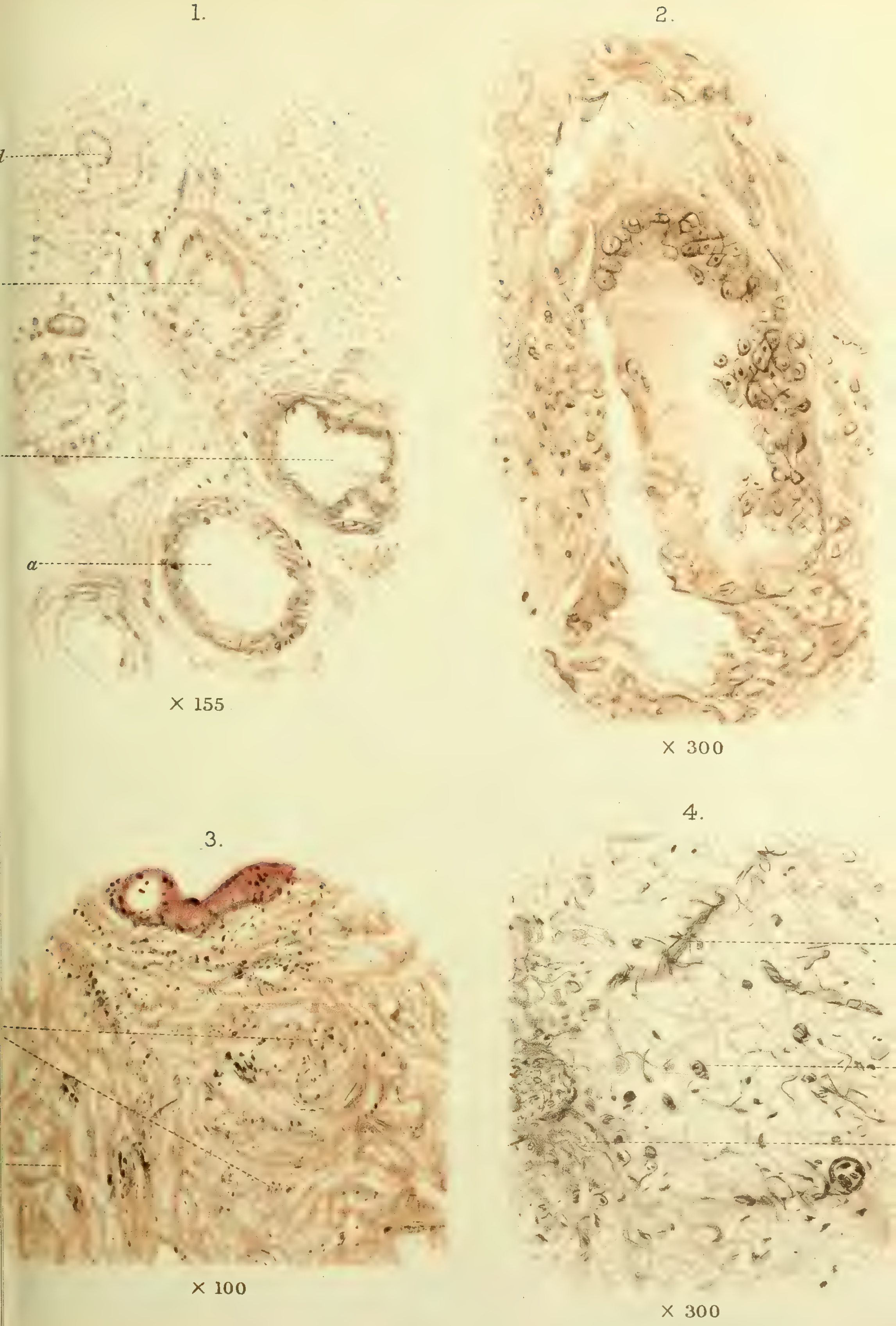
[1] Trans. Path. Soc. Lond., vol. xxxi. 1880.

[2] Dr. Stephen Mackenzie, Ibid., 1881.

[3] Lancet, July 14, and Oct. 6, 1877.

[4] Ibid., Sept. 20, 1877.

PLATE XXXIV.



TUBERCULOSIS OF THE TESTIS AND ELEPHANTIASIS OF THE SCROTUM.

H. BENCKE, LITH. N.Y.

Dr. Lewis says that the immature animal does not burst its chorional envelope, but that it stretches this, so that after a time, and before it escapes from the vagina of the parent, its shell becomes its sheath. Dr. Manson's theory is that if from some cause or another the embryonic filaria sanguinis hominis is hurried prematurely into the lymph before the stretching of the chorion commences, the consequence to the human host will be serious. In its unextended condition, the ovum measures $\frac{1}{500}''$ x $\frac{1}{750}''$, its smallest diameter being thus five times as great as that of the fully formed outstretched embryo. It passes along with the lymph-stream until it is arrested in a lymphatic too small to allow it to pass, when it blocks the tube, effectually damming up the lymph.

Dr. Manson[1] discovered the parent worm in the scrotum from a case of lymph-scrotum, from which exuded a thin, clear, straw-colored fluid which showed that there had been no regurgitation through glands; and, as no embryos could be found in the blood, but only in the lymph, they must have come from a parasite on the distal side of the inguinal glands, probably in the scrotum. Dr. Manson thinks that all the phenomena of elephantoid disease may be explained by the theory that the parent parasite is the prime cause, premature birth of the worm the second, and infarction of the lymphatic glands by the ova the immediate cause. In this case the parasite was found *in situ* in a lymphatic vessel.

Treatment.—The febrile attacks are to be treated on general principles, with salines, etc.; at a later period, tonics, especially quinine and arsenic, have been given, as also iodine; but the most potent prescription is a change of climate. Operative interference removes at once a distressing local condition, and a mass which keeps up constitutional irritation. Sir Joseph Fayrer removes the tumor by incisions along the course of the cords and the dorsum of the penis. The cord, testicles, and penis are turned out by a few touches of the knife, and are then reflected and held up on the abdomen, while the mass of the tumor is rapidly swept away by a few bold incisions in the perineum. All bleeding points, whether arterial or venous, are to be tied. No integument is to be saved, as it is unnecessary, and is likely to give rise to a recurrence of the disease. Antiseptic dressings are to be used, and in a few months the wounds will have cicatrized. Esmarch's elastic bandage and constricting cord are of the greatest value. Compression of the abdominal aorta by Sir Joseph Lister's abdominal tourniquet, or by Mr. Richard Davy's aortic lever, is to be used. Before the operation, care must be taken to reduce any rupture that may be present, to elevate the part, to make pressure on it by the elastic bandage, and to apply ice. The part has been clamped in some instances before removal; the ordinary or galvanic écraseur may be found useful in some cases, but the operation described above, when rapidly performed, is very satisfactory. The penis is always to be preserved, and the testicles in all but very large tumors; the introduction of Esmarch's bloodless method of operating facilitates their preservation.

LYMPH-SCROTUM much resembles elephantiasis scroti, and is caused by the same conditions. The local changes are due to an enlargement of the inguinal glands, arresting the circulation through the lymphatics, and causing a varicose and dilated condition of these vessels. Rindfleisch[2] considers lymph-scrotum to be a variety of elephantiasis, and calls it "pachydermia lymphangiectatica." The vesicles are cavities in the uppermost layers of the cutis itself, are caused by partial ampulliform dilatation of the superficial subpapillary network of lymphatic vessels, and are lined with characteristic endothelial cells. The unstriped muscular fibres are developed in excess, and hinder the circulation of the lymph in the substance of the corium proper.

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[1] Lancet, Jan. 1881; China Customs Med. Rep., 20th issue; Trans. Path. Soc. London, vol. xxxii. 1881.

[2] Rindfleisch, Manual of Pathological Histology, etc., New Syd. Soc., vol. i. p. 380.

Tumors of the Scrotum.—A *lipoma*, or *steatocele*, may develop in the scrotum. A scrotal fatty tumor was removed successfully by Mr. Birkett,[1] without injury to the testicles, but it does not always happen that the surgeon is so fortunate; he may find that the testicle is so intimately connected with the tumor that both have to be removed. In a case of this kind, Mr. Lane, of St. Mary's Hospital, removed a large fatty tumor together with the left testicle which was embedded in it.[2] A fatty tumor starting in the tissues of the cord will by its weight tend to gravitate downwards into the scrotum. These cases are not easily diagnosed: the mass would feel soft and doughy, resembling the feel of a piece of omentum; there would be no impulse on coughing; the most characteristic sensation would be that given by a fat-lobule. An exploratory incision would be harmless, and would clear up the diagnosis. The removal of the tumor before it has attained a large size is very desirable. M. Pelletan described a fatty tumor of the spermatic cord and upper part of the scrotum under the title of "*hernie graisseuse.*" Sir Henry Thompson removed a large adipose mass from a man 65 years old.[3] The tissues of the scrotum were thickened, and contained the fat, which invaded not only the cellular tissue of the scrotum but that of the penis also.

Fibroma of Scrotum.—Fibrous tumors of the scrotum are hard, lobulated, and inclosed in capsules, are not translucent nor fluctuant, and are freely movable under the skin, which is normal. When examined under the microscope, the section shows a fibrous or fibro-cellular structure. In some cases the tumors recur, resembling the recurrent fibroid tumors which are encountered in other parts of the body. These tumors have been met with of large size, especially in old men. They occur also in young people, and should be removed at an early date, before they have become adherent to the testicle. Sir James Paget[4] mentions several cases, occurring in old men, in which the tumors were of slow growth and of large size, weighing as much as 24 pounds.

Mr. C. Heath[5] removed a fibrous tumor with the left testicle from a man who had been troubled with the growth for thirteen years. He had become reduced by loss of blood, and by discharge from an ulcerated track which extended from the skin to the interior of the tumor, now become hollowed out and sloughy. The growth, which was in the areolar tissue of the cord, was closely attached to the back of the epididymis and tunica vaginalis.

Dr. Mott removed an enormous mass from a man aged 73; the scrotum was from twelve to fifteen times its ordinary bulk, and was filled with tumors of a stony hardness, from the size of a nutmeg to that of a large pea; the tumors had all a very white appearance; the integument over two or three of the largest had ulcerated, and discharged fetid pus and a substance like mortar. The disease had lasted for twenty years; the operation was successful.[6]

In the King's College Museum are two interesting representations of fibroma of the scrotum. One is a water-color drawing of a large, irregular, fibro-recurrent growth occupying the left side of the scrotum, which was removed several times by Sir William Fergusson. The other is a somewhat picturesque, pedunculated tumor, about the size of a large lemon, the inside of the tumor, as seen in section, being very white and fibrous, and contrasting strongly with the skin of the scrotum which covers it, and which is deeply pigmented. (Fig. 1359.) Examples of the above kind of tumor are found growing from the labia of women, and by traction become pedunculated.

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[1] Hunterian Museum, No. 2468.

[2] Lancet, vol. ii. p. 724. 1865.

[3] Trans. Path. Soc. Lond., vol. vi. p. 232.

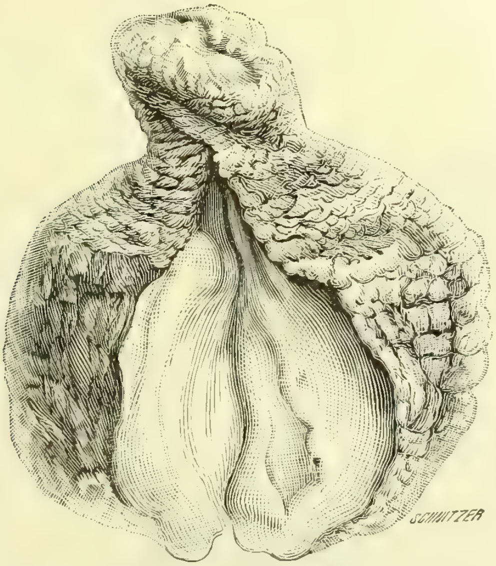
[4] Lectures on Surgical Pathology, vol. ii. p. 112.

[5] Trans. Path. Soc. Lond., vol. xvi. p. 183.

[6] Philadelphia Journal of Medical and Physical Sciences, vol. xiv. p. 335.

Cartilaginous and bony tumors of the scrotum are rare. Dr. Kerr[1] excised a dense, hard, slowly growing scrotal tumor, weighing five pounds and consisting of numerous cartilaginous lobes, in which large quantities of bone were deposited. The microscope proved one compact plate to be of genuine bone.

Fig. 1359.



Pedunculated fibrous tumor of scrotum ; surface corrugated and dark-colored, contrasting strongly with smooth, firm, white surface, presented by section.

Cystic Tumor of the Scrotum.—Mr. Curling[2] narrates an interesting case of cystic tumor of the scrotum, and gives illustrations of the case both before and after removal:—

The patient, when about 8 years old, had two or three small cysts in the scrotum, which were of the size of a horse-bean and situated beneath the integuments. The cysts increased in size and number, in spite of the use of mercurial and iodine ointments, tapping, and graduated pressure. The testicles were healthy, and below them and behind a portion of the scrotum which was inflamed and painful, a number of cysts could be felt. The whole of the diseased mass was successfully removed when the patient was twenty-two years old; the cysts were of various sizes and contained a transparent fluid. The specimen resembled a cystic sarcoma of the breast.

Dr. Bauchet[3] removed from the scrotum of a man aged thirty, a cyst which had slowly grown to the size of a small hen's egg. The cyst, which was quite distinct from the testicle, was transparent, being filled with a viscid yellow fluid, and on removal was seen to have originated in an obstructed sebaceous follicle. Dr. Fleming[4] removed from a boy's scrotum, by means of a ligature, a cyst which had followed a contusion.

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[1] North Amer. Med.-Chir. Rev., Jan. 1858.

[2] Diseases of the Testis, p. 623. London, 1878.

[3] Arch. Gén. de Méd., Janvier, 1858.

[4] Dublin Hospital Gazette, vol. iv., 1857.

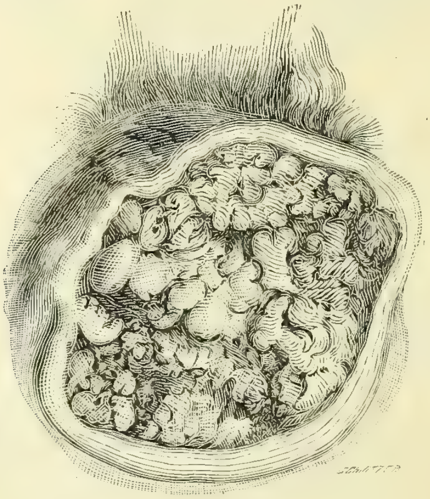
Vascular tumors of the scrotum are congenital, and may be removed by means of ligatures; or, if made up of vessels and fibrous tissue, may be dissected off, and the bleeding vessels tied.

Malignant Disease of the Scrotum.—Epithelioma is the kind of cancer usually found in the scrotum, and it most often attacks chimney-sweeps; but Mr. Craven,[1] of Hull, removed the scrotum, and with it the testicles, in a case of *medullary cancer* of its cellular tissue. Sir James Paget examined the substance of a tumor, removed by Mr. Stanley,[2] and found no epithelial cells, but bodies similar to those exhibited by *scirrhus* of the mamma.

Epithelioma of the scrotum, or "soot-wart" as it is popularly named, is well illustrated by the preparations to be found in the London Medical Museums. Before the introduction of the modern method of sweeping chimneys, this disease was common enough. The persons usually affected were the adult sweeps, who had been exposed to the action of soot on the skin for many years, but a few cases are on record in which boys engaged in the trade have been attacked. The disease is not met with in France, where wood is used for fuel instead of coal, and was said by Mr. Syme to be rare in Edinburgh. It is not prevalent in the New World, and is becoming a curiosity in this country.

Mr. Henry Smith has recently removed from a man, aged 68, at King's College Hospital, a well-marked epithelioma of the scrotum, which projected more than usual from the surface, and the presence of which was attributed to the irritation of *tar*, with which his trousers were constantly saturated. *Paraffin* also causes irritation and epithelioma.

Fig. 1360.



Chimney-sweep's cancer of scrotum; shows thickened, indurated, overhanging edges of epithelial growth.

The irritation of the soot causes enlargement of some of the papillæ of the scrotum, when a soot-wart forms which is attended with swelling and hardness; the parts when felt are indurated, the surface is uneven and covered with warty growths. There is an exudation from the surface of the mass, which is rendered dark-colored by the admixture of blood; this may dry and cake on the surface, or the surface may be moist from a free dis-

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[1] Medical Times and Gazette, vol. xx. p. 287.

[2] Curling, op. cit., p. 629.

PLATE XXXV.

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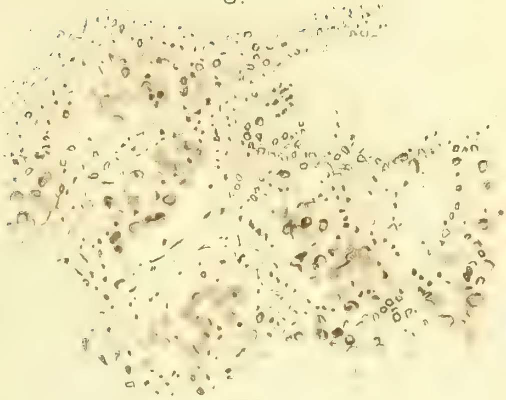

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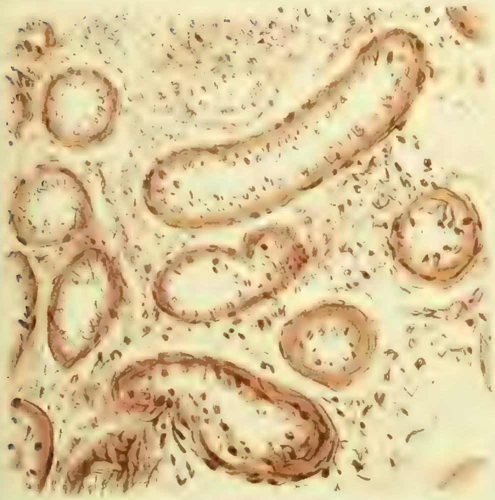

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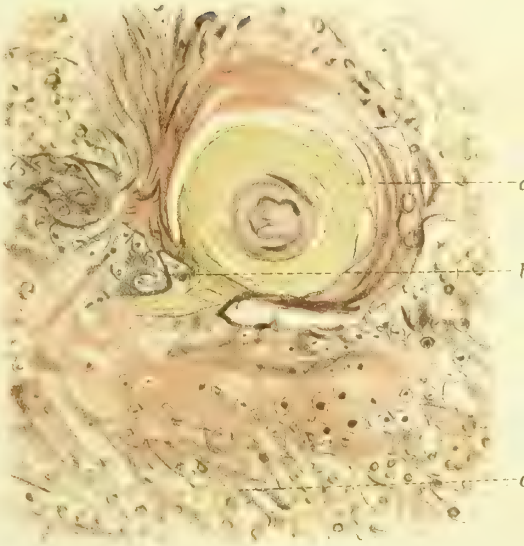

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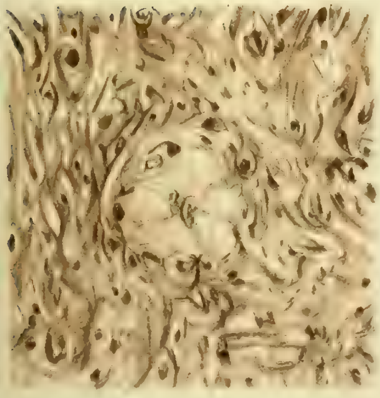

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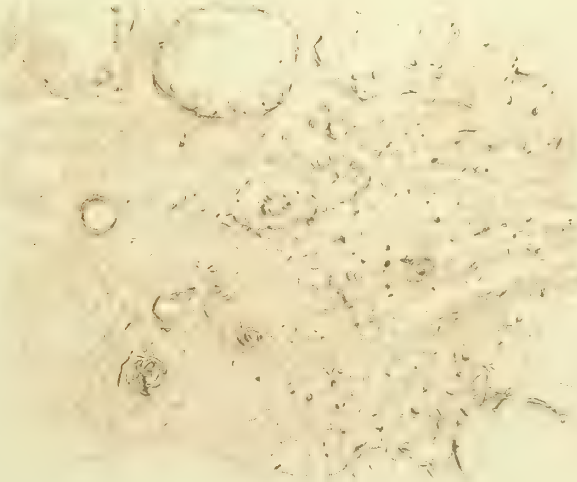

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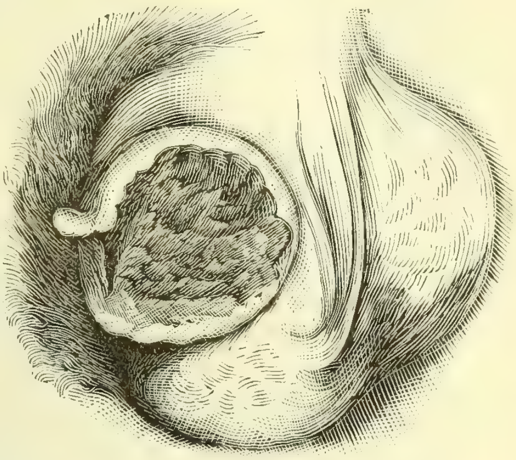
FIBROMA AND CARCINOMA OF TESTIS; RETAINED TESTIS;
EPITHELIOMA OF SCROTUM; SYPHILITIC TESTIS; DIFFUSE ORCHITIS.

H. BENCKE, LITH. N.

charge which is very offensive. In some instances horn-like projections are formed. At times the warts are numerous, becoming branched at their free portion, and forming a cauliflower-like mass. The cellular tissue becomes infiltrated, at times to a considerable extent; the skin gives way, and ulcers form, which are characterized by being attended with pain and presenting a surface which is irregular; the sore may be more or less excavated, having thick raised edges; its surface exudes thin offensive pus, and is devoid of healthy granulations, the ulceration spreading and showing no tendency to heal. The disease varies in extent; at times the whole of the skin and cellular tissue of the scrotum is converted into a thickened, indurated mass, forming a sort of cuirass inclosing the testicles, which remain healthy. The irritation of the disease causes enlargement of the inguinal glands which may subside after operation. If an operation be declined, the glands in the groin become infiltrated with cancer-cells, enlarge, often soften, and ulcerate extensively. In consequence of great pain, free discharge, and repeated bleedings, the patient becomes cachectic and gradually sinks. Free removal of the disease is the only treatment to be recommended, and this is fortunately attended with much success, as the lymphatic glands are affected late in the disease; if not much implicated, they should be dissected out at the time of the operation. When the case is not one suited for operative interference, opium is to be exhibited freely to relieve pain, and various antiseptic applications may be made to correct the fetor. The warts are not unlike those met with under other circumstances, but the cancer-cells infiltrate the surrounding tissues, which ulcerate, and the disease extends, affecting the skin superficially and showing no tendency to heal. The appearance, occupation, and history of the patient must be carefully considered in arriving at a diagnosis.

Fig. 1361.



Epithelial (chimney-sweep's) cancer of scrotum; early stage.

Mr. Curling narrates a case of subcutaneous tumor, probably developed in one of the follicles of the scrotum, which was the size of a hazel-nut, and wholly composed of epithelial cancer-tissue, the skin covering it being unbroken, though adherent to the growth.

Sir James Paget[1] says that soot does not determine the growth of cancers, but produces a state of skin which provides an apt locality for epithelial cancer in persons of a cancerous diathesis.

On microscopic examination of scrotal epithelioma, masses of large cells are seen, some of them containing epithelial nests. In some are sections of hairs, very much enlarged and altered. Between the masses of large epithelial cells, there is a fibrous stroma containing round cells. The specimen from which the drawing (Plate XXXV., Fig. 8) is taken has been doubly stained; the masses of large epithelial cells have taken one color (red), while the cells in the stroma have taken another (green).

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[1] Op. cit., vol. ii. p. 465.

The disease has been met with in several members of the same family.

Sir James Earle[1] operated on a patient whose grandfather, father, and one brother had all perished from the effects of the disease. Mr. Hawkins[2] states that a father and son were in St. George's Hospital at the same time suffering from the affection.

Chimney-sweep's cancer may attack other parts of the body besides the scrotum. In one instance a gardener who had carried a pot filled with soot hung over his left wrist, was affected by the disease.

Sir William Lawrence[3] writes that he had had occasion, in a few instances, to remove chimney-sweep's cancer from other parts of the body, for instance, before and behind the ear; the swelling was not hard, but solid and firm, nearly equal in size to the last phalanx of the thumb, and without breach of surface.

In a remarkable case of chimney-sweep's cancer in the axilla, Mr. George Lawson[4] ligatured the axillary artery and amputated the arm at the shoulder-joint. The patient, aged 61, a sweep, had begun, long before, to suffer from "soot-wart," but it had given little trouble for fourteen years, and had been operated on several times; there was no glandular enlargement in the axilla or neck.

The disease has been encountered in persons who were not sweeps, and in others who, having been sweeps in their youth, had for many years quitted the occupation. After removal, the disease may appear in a fresh part of the scrotum, the cicatrix remaining quite sound.

The *prognosis* is favorable in these cases, as the disease is superficial and can be thoroughly removed when taken in time; the inguinal glands are not affected till late in the disease.

Mr. Curling narrates an interesting case of a sweep, aged 51, who had been operated on five times in twenty-two years. The glands in one groin became affected and ulcerated only a few months before his death. No trace of internal disease could be detected, the cancer being strictly limited to the scrotum and groin on one side. Sir Wm. Lawrence[5] removed the scrotum and both testicles from a patient who was alive and well thirty years after the operation.

Treatment.—The diseased parts are to be included between two elliptical incisions, and freely removed from the surrounding parts. The enlarged inguinal glands may be dissected out, if their enlargement be due to cancerous deposit, and their removal be deemed advisable.

Melanosis of the scrotum is a rare affection. Mr. Curling gives the particulars of a case which occurred in his practice:—[6]

A man, aged 32 years, had in Nov. 1842 a pedunculated scrotal tumor of the size of a small walnut, which was dark-colored, and had an irregular, granular surface. It had been three months growing, and had increased rapidly of late, but was not painful. The glands were not enlarged. On section the fungus appeared to spring from the cutis. Its base was hard, but the projecting part was friable; small black spots were scattered through the section of the tumor. The wound healed well, but the tumor reappeared near the cicatrix, and the glands in the groin became indurated. In March, 1844, there was a firm indurated mass about the size of an almond in the scrotum, implicating the cicatrix, and an enlargement of the inguinal glands forming a tumor of the size of an orange, and a smaller swelling the size of a hen's egg. He died in 1848, four years subsequently, from repeated hemorrhage from the rectum, having lived six years from the first appearance of the disease. The induration in the scrotum was tinged with pigment, and the glands in the groin were soft and brain-like; the lumbar glands were slightly enlarged, and quite black on section.

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[1] Med.-Chir. Trans., vol. xii. p. 305.

[2] Lectures on Tumors, London Med. Gaz., vol. xxi. p. 842.

[3] Lectures on Surgery, p. 568.

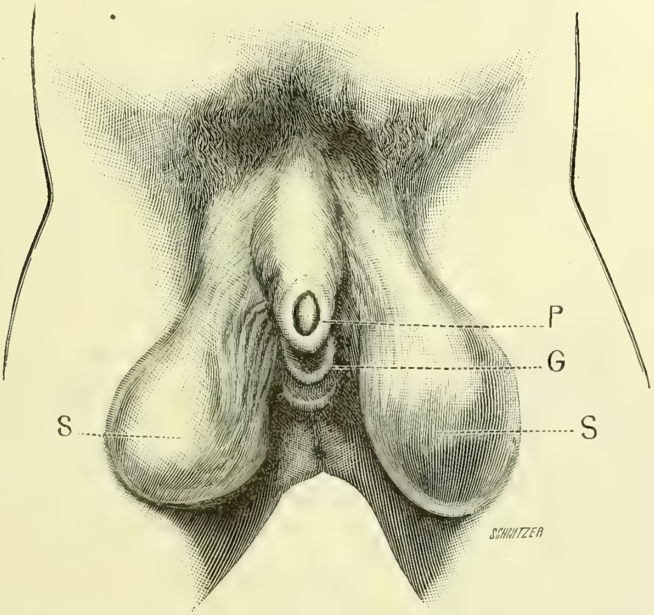
[4] Trans. Clin. Soc. Lond., vol. xv. p. 165.

[5] Op. cit., p. 567.

[6] Op. cit., p. 643.

Cleft Scrotum.—The scrotal variety of hypospadia is the most interesting to the surgeon, and the most formidable to the patient. The scrotum is cleft and presents a *cul-de-sac*, lined with a smooth membrane, at the bottom of which is the opening of the urethra. The penis is undeveloped, and the glans imperforate; the prepuce is voluminous above but wanting below, giving the organ the appearance of a large clitoris; the scrotal folds extend from the upper surface of the penis downwards on each side, and the parts resemble at first sight the vagina and labia of a female (Fig. 1362). This condition is often associated with the absence of testicles from the scrotal folds, and the presence of inguinal rupture. When passing water, the patient has to stoop in order to prevent it from running down his legs. When the testicles are present the patient has erections, but is unable to have fruitful intercourse.

Fig. 1362.



Cleft scrotum. *P*, ill-developed, clitoris-like penis; *G*, orifice of genito-urinary sinus; *S*, *S*, cleft scrotum containing small but normal testicles.

The condition called *hermaphroditism* is said to exist, but must be exceedingly rare; in these cases the unfortunate must possess the genital organs of both sexes. The sex of some of these patients with scrotal hypospadia is difficult to determine during life, unless the sexual characteristics are well marked, and the testes are present in the scrotal folds; and many cases have been met with in which the sex of the individual has been mistaken. The error is often discovered and rectified on the advent of puberty. A man with this deformity passed as a woman until his father's death, but then discarded his petticoats, and claimed a son's, instead of a daughter's, share of his father's estate. An endeavor must be made to discover the testicles in the cleft scrotum, if the patient incline to the male sex; or the uterus must be sought by introducing a sound into the bladder and a finger into the rectum, and feeling for it between the two, if the patient be of the female sex.

Mr. John Wood showed, at the Pathological Society of London, the pelvis and genital organs of a so-called adult hermaphrodite. This epicene individual was aged 60 years, then passed as a woman, and had been married to and deserted by a man. The general appearance of the body was that of a female, 5 feet 9 inches in height, with long iron-gray hair and rather strongly marked features. There was some dark-colored down upon the upper lip, and there were a few long straggling hairs about the chin. The skin was soft, smooth, and tolerably fair; the mammæ were woman-like, with fairly developed, prominent nipples; the left weighed $2\frac{3}{4}$ oz., the right $2\frac{1}{4}$ oz.; the hairs in the axillæ and on the pubes were few and scattered. An imperforate penis, about the size of the organ in a boy of ten years, simulated a very large clitoris, and was provided with an oval glans about $\frac{3}{4}$ of an inch in diameter. The prepuce formed a perfect fold or hood above, but was split below, where it ended on each side in a well-formed labium minus, which passed down and was finally lost in a sort of posterior fourchette. An indication of a flattened and imperfect frænum was seen below the glans. About $\frac{3}{4}$ of an inch below this was the oval opening of a *cul-de-sac*, in the situation of the vagina, admitting a bougie $\frac{3}{4}$ of an inch in diameter to the extent of fully two inches; the *cul-de-sac* was lined with a smooth membrane quite free from rugæ. The labia majora were very voluminous, and hung free from the perineum like a split scrotum, meeting by a fold of skin or fourchette behind and below the vaginal opening. Within each was easily seen and felt a full-sized, plump, and well-formed testicle, suspended by a cord and covered with all the usual coverings of the latter; the crura penis were well formed, fair sized, and provided with an erector penis muscle. The bulb or semibulb of the spongy body was of quite the adult male size, and lay upon and covered each side of the vaginal tube. Upon it lay the half of the accelerator urinæ muscle of the same side, and below and behind was a well-marked broad transversus perinei muscle. The triangular ligament and the deep compressor urethræ muscles lay deep behind and above the vaginal pouch, and supported a prostate gland. The vasa deferentia and vesiculæ seminales were quite normal. The prostate, situated above the false vagina, inclosed the urethra, which opened about one inch from the orifice of the *cul-de-sac*.[1]

In another case the patient during life had passed as a woman. The organs, on post-mortem examination, did not exhibit simply an arrest of growth, but showed that the deviation from the normal standard had taken place in the direction towards the male sex; thus, not merely were there a want of vagina, a small uterus, and an imperfectly developed single ovary, but the enlargement of the clitoris, the long urethra, and the prostate, approximated in character to the organs of the male.[2]

HYDROCELE.

COMMON VAGINAL HYDROCELE.—By the term *hydrocele* is meant an accumulation of serous fluid in connection with the testis or cord. When the tunica vaginalis, which covers the testicle and lines the scrotum, is affected with acute or chronic inflammation, it secretes, like other serous membranes, a quantity of serous fluid which causes a distension of the tunic, and the condition known as the common or vaginal form of hydrocele. The inflammation may be acute, but it is more often chronic and unattended by marked symptoms. At times the effusion is caused by secondary cysts contained within the tunica vaginalis, by loose bodies, by varicocele, by operations implicating the vaginal tunic; and of late it has been ascribed in some cases to the presence of the Filaria Bancrofti.[3]

Mr. Curling's valuable table exhibits the different varieties and complications of hydrocele:[4]—

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[1] Trans. Path. Soc. Lond., vol. xxiii. p. 169.

[2] Ibid., vol. xi. p. 158.

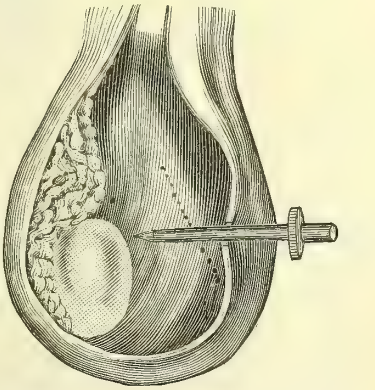
[3] Ibid., vol. xxix.

[4] Op. cit., p. 96.

- Hydrocele
  - Of the testicle,
    - Vaginal,
      - Common,
      - Inguinal,
      - Congenital.
    - Encysted,
      - Of the epididymis,
      - Of the tunica albuginea.
  - Of the spermatic cord,
    - Diffused,
    - Encysted,
    - Congenital.
  - Complications of
    - Vaginal hydrocele combined with encysted hydrocele of the testicle,
    - Vaginal hydrocele combined with encysted hydrocele of the cord,
    - Vaginal hydrocele combined with diffused hydrocele of the cord.
    - Oscheo-hydrocele,
      - Vaginal hydrocele combined with inguinal hernia,
      - Encysted hydrocele of the cord combined with inguinal hernia.
  - Of the hernial sac,
    - True,
    - Spurious.

In recent cases the tunica vaginalis is transparent and smooth, but the connective tissue becomes thickened. In cases of long standing there are evidences of inflammation; membranes of newly formed tissue which are sometimes vascular, sometimes non-vascular, are deposited in layers on the surface of the parietal and testicular layer of the serous membrane. These deposits become dense and tough like similar deposits seen in cases of pleurisy and pericarditis, and are formed of parallel layers of connective tissue separated from one another by flat cells; between these layers and the connective tissue, effusion of blood may take place. Small, dense, pearl-like bodies occasionally become free in the serous cavity, in the same manner that false cartilages do in joints. The tunica vaginalis may be so thickened, and so indurated by the deposit of calcareous salts, that it cannot collapse on the testicle, which may become atrophied in consequence. In cases of recent inflammation, the effused lymph is soft and glues together the parietal and visceral layers of the tunica vaginalis. When the tunica vaginalis is inflamed the epididymis is also liable to be attacked, as the inflammation is propagated by the cellular tissue connecting these parts, whereas the testicle is protected by the tough tunica albuginea. Inflammation of the tunica vaginalis is very rarely followed by suppuration. Hydroceles are often secondary to syphilitic disease of the testicles, to elephantiasis scroti, and to malignant disease.

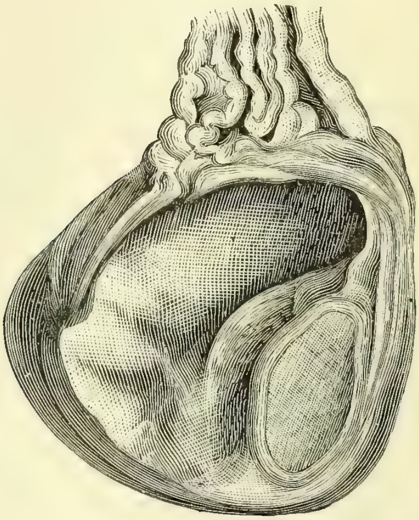
Fig. 1363.



Relation of parts in vaginal hydrocele: the dotted lines show the oblique direction to be taken by the trocar in tapping, in order to avoid the testicle.

Nature of the Fluid.—The fluid drawn off from a hydrocele is generally yellowish, has a specific gravity of 1024, and becomes solid on the application of heat and nitric acid. At times it has a brownish tinge from the admixture of blood, but it may be of a dark greenish-brown color, and so loaded in old cases with cholesterin, the crystals of which sparkle in the fluid, that this condition, combined with a somewhat thickened sac, prevents the transmission of light. Sufficient blood may be effused after the swelling has been tapped, to render the fluid quite dark-colored and the swelling non-translucent. Dr. Marcet's[1] analysis of 1000 grains of this fluid, of the specific gravity 1024.3, gave 80 grains of solid matter (animal 71.5; saline 8.5). The serum of the blood (sp. grav. 1025–1030) contains more animal matter than the hydrocele fluid.

Fig. 1364.



Transverse section of vaginal hydrocele. The testis, which is normal, is seen behind, covered by the tunica vaginalis, which is much dilated and thickened; the constituents of the cord are seen above.

In the Anatomical Museum at King's College, is an interesting specimen of fluid which was removed from a hydrocele by the late Sir William Fergusson. At the present time it looks like semi-solid mutton-fat. It was shown at the Pathological Society of London, and reported on by Dr. Harley and Mr. Mason,[2] who found that the white milky appearance was due to fat-globules. No spermatozoa were discovered. The fluid was taken from the hydrocele of a healthy German, aged 42, who was tapped three times in twelve months, fluid of this peculiar character being drawn off each time. The swelling fluctuated, but was not examined in regard to transparency. M. Vidal (de Cassis) met with a case of non-transparent double hydrocele containing a similar fluid, and in his treatise on surgery gave the name of Galactocele to this condition; a name not strictly accurate. Another case is quoted from Sichel's Thesis (Zurich, 1833). The sp. grav. was 1019, whereas that of milk is 1030–1034. This variety of hydrocele fluid contains albumen and sugar, and the white color is due to large granular cells and oil-globules, which dissolve in ether and leave the fluid clear. Stellate crystals of margaric acid form after a time. The presence of fat-globules in hydrocele fluid is considered by Klebs to be due to a fatty degeneration of the endothelial cells. The fluid is of a chylous nature, and is frequently associated with filariæ in the fluid and blood; which is explained by the parent parasite being located in the lymphatics of the cord, or in glands situated higher up the lymph circulation. This explains the double enlargement of the inguinal glands in one-sided elephantiasis, and the so-called metastasis of the disease.

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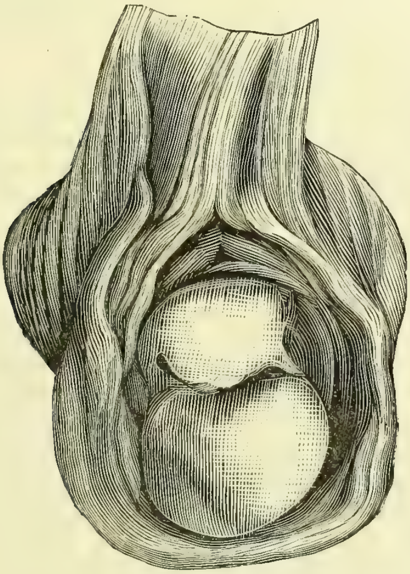
[1] Medico-Chir. Trans., vol. ii. p. 372.

[2] Trans. Path. Soc. Lond., vol. xvi. p. 184.

Fig. 1365.



Vaginal hydrocele with disease of testis: *A*, testicle enlarged and containing cheesy matter; *B*, epididymis also showing strumous softening; at *C*, *C*, the hydrocele appears to have been partitioned off into separate cysts, or to contain small cystic hydroceles.

The quantity of fluid removed from a hydrocele, varies a good deal; about ten ounces is an average quantity, when the hydrocele is of a good size. Mr. Cline is said to have removed from Gibbon, the historian, who suffered from an enormous hydrocele, as much as six quarts. Mr. Curling questions the existence of multilocular hydroceles formed by the effusion of fluid into cysts caused by adhesions, such as have been described by some authors. Mr. Curling has called attention to a kind of sac or pouch often met with in hydroceles, situated on the inner side of the testicle, and the opening into which is to be found on the outer side, between the body of the testicle and the middle of the epididymis.

As seen by museum specimens, the tunica vaginalis is very much thickened; the parts around, as in cases of old standing herniæ, in consequence of the weight which they have to support, also become thickened. The cremaster muscle is hypertrophied, or spread out over the tumor and thinned; the tunica vaginalis is also thickened where it covers the testicle, which, however, remains healthy.

The disease occurs at all ages, but is most frequent in infancy and middle life, and is found generally on one side only, though it may be double. Most observers say that the left side is the one most commonly affected, but the difference is but slight; in about ten per cent. of all cases, the hydrocele is double.

Any cause that induces a flow of blood to the testicle, or prevents its return, may cause a hydrocele to form. In tropical climates the disease is frequent, and Sir Joseph Fayrer found that in India it was often to be ascribed to a malarial cause. Dr. Manson suggested that the disease in China was at times produced by slight obstructions in the lymphatic vessels, owing to the presence of filariæ. Dr. Bancroft has discovered microscopic filariæ in the chylous fluid removed from a hydrocele. He has also found adult filariæ (Filariæ Bancrofti) in clear fluid.[1]

Injuries or strains at times give rise to hydrocele. In cases of dropsy, the scrotum and penis are much distended with fluid, but the tunica vaginalis is empty; in one case, owing to a communication existing between the tunica vaginalis and the peritoneal cavity, the former was much distended by the ascitic fluid. In some instances a loose body in the tunica vaginalis will cause a hydrocele which is difficult to cure. Relapses after operation also occur when the hydrocele is associated with chronic orchitis, a condition of things to which the term hydro-sarcocele has been applied. The irritation set up by tubercle, or by simple or malignant tumors of the testicle, causes effusion into the tunica vaginalis, which adds to the difficulties of diagnosis.

Symptoms.—In general there is no difficulty in diagnosing cases of vaginal hydrocele, which, owing to the absence of pain, are, as a rule, of some size before they attract the patient's attention. The swelling first shows itself at the lower part of the scrotum, and gradually makes its way upwards towards the inguinal canal; it is pyriform in shape, with the apex or stalk of the pear, formed by the spermatic cord, upwards; the cord usually can be easily felt. On balancing the tumor in the hand, it is found to be much lighter than its size would seem to indicate, and on squeezing it, if it be not very tense, the fluid can be shifted from one part of the swelling to another; on tapping it sharply with the middle finger of the right hand on its front aspect, as it rests in the palm of the left hand, the vibrating thrill so characteristic of fluctuation will be readily perceived. In most cases the swelling is transparent, as can be demonstrated in several ways. The swelling may be made as tense as possible by grasping it above and behind with one hand; the ulnar side of the other hand and the little finger are then placed along the front, convex surface of the tumor, and, the room having been darkened, a light supplied by a taper or wax match is placed so as to illuminate the swelling and the back of the hand. If the swelling be transparent a red glare will be seen, and the situation of the testicle will be marked by the dark shadow caused by its want of transparency. For the purposes of class demonstration, the use of the darkened ophthalmic room is convenient.

The electric incandescent coil contained in a small glass globe, which has been devised for the examination of throats, is likely from its brilliancy of illumination and convenience of application, to be useful in demonstrating the transparency of a swelling, especially in cases of encysted hydrocele of the cord, where the application of a naked light is awkward.

On taking a patient into the ophthalmic room for the purpose of examination, or rather for demonstration, for I had tapped the man some time previously for hydrocele and had also demonstrated on that occasion its transparency, I was surprised to find that the swelling was no longer transparent; fluctuation was, however, very evident, so that I introduced a trocar and canula, and drew off some blood-stained fluid. The man, who was a shoemaker, informed me that he had struck the part shortly before coming the second time, and had so caused the early reappearance of the tumor and its want of transparency. When the extravasation of blood is extensive, a hæmatocele will result. It is sometimes convenient to illuminate one side of the swelling, and to look through it by means of a stethoscope applied to the opposite side. It is of importance to ascertain the position of the testicle. This is generally situated two-thirds of the way down the tumor, at its posterior part, but at times, owing to adhesions between the visceral and parietal layers of the tunica vaginalis, or to the displacement of the testicle owing to the condition known as *inversion* of the testicle, the organ is found at the front part of the swelling, at the point usually selected for tapping.

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[1] Trans. Path. Soc. Lond., vol. xxiv. 1878.

Dupuytren, having satisfied himself of the transparency of a hydrocele, made a puncture towards the anterior and lower part; but the testicle was there, and was pierced through by the trocar. Having withdrawn the trocar from the canula, he injected the tunica vaginalis; the patient recovered without further accident. As a rule, it would be safer not to inject under similar circumstances.

In the few cases of the kind which have come under my notice, I have felt the vas deferens running in front of the other constituents of the cord, instead of behind, as it generally does. In one case, a youth was suffering from acute gonorrhœal epididymitis associated with the effusion into the tunica vaginalis; the testis and epididymis were in front, the hydrocele being situated behind. In the second case, a young man presented a medium-sized, slightly tense hydrocele; the testis was to be felt distinctly in front of the swelling, and the vas deferens ran up the front of the cord.

The symptom of transparency, which is so valuable when present, is absent when the contents of the sac are dark-colored from the presence of cholesterin or blood, or when the tunica vaginalis is much thickened; M. Gosselin has found that swelling of the testicle also will cause transparency to be absent, but the reason for this is not apparent.

It has been stated by Arnaud and Teale that the sac of a scrotal enterocele may be so distended as to become transparent; it would also be tympanitic.

M. Duval[1] narrates the particulars of a case of subacute blennorrhagic epididymitis which came under M. Nicaise's care, and which exhibited a tolerably abundant effusion into the tunica vaginalis, accompanied by total translucency. This was the more remarkable, since by palpation the dimensions of the testis and epididymis, which were considerable, were easily ascertained. The fluid removed scarcely equalled in volume the solid mass that remained in the scrotum. In an infant the hydrocele was completely transparent. M. Duval finds that this occurrence is chiefly but not exclusively confined to idiopathic hydrocele. M. Nicaise says that it is due to the complete reflection which takes place from the unaltered serous surface of the tunic bathed in the liquid; a solid tumor with liquid may appear to be almost entirely liquid, or more liquid than it really is.

The gland will be best avoided by ascertaining its exact position by illumination and palpation. By carefully pressing on the different parts of the swelling, the patient, when the testicle is reached, will experience what is termed testicular sensation, that is, the peculiar sickening feeling caused whenever the testicle is roughly squeezed; and the part will feel firm instead of fluctuant. At times the swelling is not of a regular pyriform shape, but is constricted like an hour-glass.

Last season, a boy sixteen years of age presented himself at King's College Hospital with a double vaginal hydrocele; the swellings were very transparent, that on the right side being larger than that on the left; they were both of the hour-glass shape, and presented an interesting exemplification of this condition, which was due to the unequal expansion of the lower and larger part of the tunica vaginalis, contrasting with the upper, smaller, constricted portion which runs up towards the cord.

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[1] Gaz. des Hôp., Juin, 1868.

When inflammation has taken place, the hydrocele may be of an irregular shape, owing to adhesions. The most interesting cases of hydrocele, from a diagnostic point of view, are those in which the tumor runs up the cord and makes its way into the abdomen, presenting a swelling which obscures the cord, and has, like hernia, an impulse transmitted to it on coughing.

Vaginal hydroceles not only reach to and distend the external abdominal ring, but, when a hernia is present, may act as a plug and keep the rupture within the abdomen, and it is interesting to note that cases of hydrocele, generally of the cord, which pass into the abdomen through the inguinal canal, are not associated with a rupture, and do not give rise to one when cured by operation.

Sir Joseph Lister[1] has reported an interesting case in which a *vaginal hydrocele* passed through the inguinal rings into the abdomen, where it formed a swelling in the hypogastric and iliac regions, and assumed in consequence an hour-glass shape. It differed from a hernia in that it fluctuated; it was only partially reducible, and there was an interchange of size between the internal and the external swelling when they were alternately pressed upon. After death an hour-glass shaped tumor, formed by a single cyst—the left tunica vaginalis—which passed over to the right side, was removed. The lower part of the hydrocele was somewhat stomach-shaped, with a large projection above connected to it by a narrow neck which passed through the left inguinal canal, and a small one on the right which projected over to the right external ring. The tumor, which was partially distended with cholesterin-bearing fluid, was beneath the peritoneum lining the iliac fossa and the lower part of the anterior wall of the abdomen. It was lined with a smooth serous membrane, and the testicle, smaller than usual, projected into the cavity, covered by its lining membrane.

An interesting example of hydrocele with hour-glass contraction is described by Dupuytren. A portion of the tumor occupied the scrotum, whilst the other part was in the abdomen, and spread itself above the ring which, by its constriction, caused the tumor to assume an hour-glass shape. When the patient stood up the visible portion of the tumor filled, and it became distended when he coughed ; but it became emptied, on the other hand, when he was in the horizontal position or when it was pressed. The abdominal portion of the tumor, and the right iliac region, then became raised and distended. Incision was the method of treatment adopted.

Dr. Kocher,[2] of Bern, calls special attention to a form of hydrocele in children, in which the fluid is forced by pressure into an intra-abdominal sac, and not into the peritoneal cavity. Dr. Kocher's cases were cured by iodine injection.

Treatment.—Spontaneous cure is common in cases of infantile hydrocele, but is very rare in the adult, although a few cases are on record. In infants it is only necessary to apply a piece of lint which is kept well saturated with a muriate-of-ammonium and spirit lotion. If this fail, the tunica vaginalis may be punctured in a few places with a needle (acupuncture), and should further treatment be necessary, a few threads of silk passed through the swelling, and allowed to remain for a few hours, will drain the hydrocele and set up enough irritation to bring about a cure. But, as a rule, the use of the lotion, or the application of weak tincture of iodine or collodion to the scrotum, as recommended by Mr. Curling, will suffice. In the adult, stimulating applications and blisters are of so little use that it is a waste of time to attempt a cure by their means.

When a hydrocele has accidentally burst, a large swelling ensues from extravasation of the fluid from the tunica vaginalis ; this becomes absorbed, but collects again in the tunica vaginalis, the rent in which heals in due time.

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[1] Edinburgh Medical Journal, Sept. 1856.

[2] British Med. Journ., vol. ii. 1878.

If inflammation were to attack the tunica vaginalis, a cure would result, but not otherwise. Sir A. Cooper performed the usual operation for hydrocele in a case where the sac had been ruptured.

The *palliative treatment* of hydrocele, by tapping, is adopted daily, and is, as a rule, free from danger. The operation is such a simple one, that the accidents which do occur usually arise from want of care. Having ascertained that the swelling is a hydrocele, the surgeon places the patient with his back to the wall, or on a couch, and, having carefully determined by palpation that the swelling fluctuates at the point selected for puncture, and that the testicle is absent from that spot, he makes the swelling very tense by placing it in the palm of his left hand and grasping it firmly, making his fingers and thumb encircle the spermatic cord, and then thrusts a sharp, well-oiled trocar and accurately-fitting canula obliquely upwards into the swelling, taking care to avoid any vein; as soon as it has entered the tunica vaginalis, the trocar is withdrawn, and the canula is pushed in up to its guard. The most convenient spot for the puncture is at the front part of the hydrocele, a little below its centre. The palliative treatment of tapping is most applicable to large hydroceles, in order to reduce their bulk prior to the radical cure, and to hydroceles occurring in old men, which may be tapped periodically. After the operation, the patient, if old and feeble, should remain quiet in order to avoid accidents. Sir A. Cooper lost an old gentleman from gangrene of the scrotum after this simple operation, because he did not keep quiet. Mr. Green also lost an aged patient. No dressing is required for the wound, which heals in a few hours. It is safer to evacuate the fluid with a trocar and canula than with a lancet, which is liable to wound a vessel. Acupuncture has been used to evacuate a hydrocele; the fluid is effused into the cellular tissue, where it causes a swelling, but soon becomes absorbed. The hydrocele re-forms, but more slowly, it is said, than after tapping.

Radical Cure of Hydrocele.—(1) *Incision* is an old plan of treatment; the hydrocele is completely laid open by an incision, and the testicle is exposed; suppuration soon takes place, and is encouraged by stuffing the wound with lint, or by dusting the sac of the tunica vaginalis with flour. Severe local and general symptoms follow the operation.

(2) *Excision* has been performed in some cases in which it has been found that simple incision of the hydrocele has failed to cure. Sir A. Cooper says of both methods that they are too dangerous and too cruel for so trifling an inconvenience.

(3) *Caustics* used to be employed in some cases; potassa fusa was applied to the front of the scrotum, till an eschar the size of a sixpence was formed. This caused consolidation of the tissues around, and an opening in the tunica vaginalis; inflammation and granulations followed, and joined the parts together. The remedy was found to be uncertain and dangerous to life, as a specimen in the Hunterian Museum demonstrates.

(4) *Tent and Seton.*—Baron Larrey, having made an opening into the tunica vaginalis, used to leave in the cavity a gum-elastic catheter as a *tent.* Monro retained the canula *in situ.* Other foreign bodies have been introduced. The *seton* was much used by Mr. Pott. Having tapped the hydrocele with a trocar and canula, he withdrew the former and introduced through the latter a stylet four inches and a half long, with a triangular point at one end and an eye at the other, through which some threads of silk were passed. This stylet was thrust through the tissues from within outwards, and drawn out leaving behind it the seton. The tunica vaginalis and testicle became swollen in twenty-four hours; the seton was gradually removed, a few threads at a time, beginning about the tenth or twelfth day. Drs. Young

and Gillespie have tried the effect of silver-wire setons instead of silk, but a good deal of inflammation is thus set up. I have tried this plan myself, but have given it up as causing too much irritation; the wounds made by the wire heal slowly. Mr. Curling carries a double silk thread through the skin and tunica vaginalis with a curved needle, leaving a space of an inch or an inch and a half between the ends of the threads, which are withdrawn on the third or fourth day. Setons are now but rarely used, owing to their uncertain action, but are reserved for cases of cystic hydrocele, and for others which have resisted the ordinary methods of treatment.

(5) *Injection.*—The treatment of hydrocele by injection was known to the ancients. Celsus recommended a solution of nitre. Monro, Sharp, and others employed the method, but used so strong a solution that much pain and irritation ensued. Sir James Earle revived the operation for the radical cure of hydrocele by means of injection, in 1791. Port wine and water was the favorite fluid, and spirit was also tried; but as these solutions varied a good deal in strength, a solution of sulphate of zinc, in the proportion of one drachm to a pint of water, was found to be more reliable. A syringe capable of holding from eight to sixteen ounces was used. Sufficient fluid was thrown into the sac of the hydrocele to distend it to its original size; after retention of the fluid for a few minutes, it was allowed to escape through the canula, and then some fresh fluid was injected in the same manner as before. The operation of injecting a hydrocele is attended with pain, which runs up the spermatic cord to the lumbar region; the degree of pain varies in different cases, and is no test of the success or failure of the operation.

Sir Ranald Martin recommended the use of tincture of iodine, one part to three of water; a small syringeful of the fluid was to be thrown in and allowed to remain. Out of 2393 cases,[1] failure is said to have been met with in only one per cent. Mr. Curling uses the following solution: Iodi, ʒij; Potassii Iodid. ʒss; Sp. Vin. Rect. f℥j. Inject fʒi–ij, and allow the injection to remain. In young persons it may be used of half the strength. Sir William Fergusson injected the simple tincture of iodine, diluted as recommended by Sir Ranald Martin, and used for this purpose a small glass syringe with a platinum nozzle, which fitted accurately into the canula, and held about a drachm or two of fluid, a quantity sufficient for the cure of the largest hydrocele.

Having tapped the hydrocele in the usual way, the surgeon withdraws the trocar, pushes the canula up to the guard, carefully draws off all the fluid, and throws in the injection. The liquid is diffused throughout the tunica vaginalis by shaking the sac, and the canula is then withdrawn; the patient remains in bed after the operation, or, if the inflammation be not too severe, he may walk about the house. Generally in a day or two the swelling is almost as large as it was before the operation, but it soon subsides, and as a rule a cure results. Mr. Curling thinks well of the suggestion of Dr. Ayres, and has applied strapping after tapping and injection, and in some instances within an hour of the operation. The size of large hydroceles should be reduced by repeated tappings before injection.

After a hydrocele has been tapped, and before it is injected, a careful examination of the testicle should be made; the gland is often enlarged, and if it be affected with syphilitic orchitis, suitable anti-syphilitic remedies should be administered. At times a cystic hydrocele is found coexisting with a vaginal hydrocele, and in some cases loose bodies will be found in the tunica vaginalis. If two hydroceles coexist, they may both be tapped and injected at the same time, as the operation is a mild one. When the hydrocele cannot be cured by injection, the more severe plan of passing a seton may be resorted to, or better still the antiseptic incision.

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[1] Lancet, vol. i. 1842.

A man aged fifty-one, under Professor Billroth's care, presented a tumor in the scrotum, which had existed for ten years and was the size of a fist and of almost bony hardness. The tunica vaginalis had to be laid open with bone pliers, as its inner surface was covered with layers of *calcareous deposit;* most of these were removed, and the rest were thrown off by subsequent suppuration.

Mr. Jacobson[1] reports that, of forty-four cases which had been injected with iodine at Guy's Hospital, the treatment failed in eight cases, and in two it failed twice. The causes to which failure to cure a hydrocele may be most commonly attributed, are excessive thickening of the tunica vaginalis, which is unable to collapse; syphilitic disease of the testicle; and the presence of cystic hydrocele of the testicle, and, on some very rare occasions, loose bodies in the tunica vaginalis. It is necessary to empty the sac thoroughly and to use a solution of iodine of sufficient strength; fewer failures will follow the use of a strong, than that of a weak tincture.

Nitrate of silver has been introduced into the tunica vaginalis for the radical cure of hydrocele by M. Maisonneuve. This may be done by passing a silver probe coated with the salt through the canula before its withdrawal, and touching the membrane freely; or a director carrying a little powdered nitrate of silver in its groove may be passed through the canula and made to deposit the powder within the cavity. *Iodoform* has been introduced for the cure of hydrocele much in the same way, and has proved successful. M. Monod,[2] having withdrawn a small portion of the fluid, injects a little *alcohol.* *Carbolic acid* has been much lauded by Dr. Levis,[3] of Philadelphia, because he finds that it produces just the proper degree of inflammation necessary to cause the deposition of plastic lymph, and because it is less painful than the injection of iodine. After tapping in the usual way, Dr. Levis, by means of a syringe having a nozzle sufficiently long and slender to reach entirely through the canula, injects about one drachm of crystallized carbolic acid, maintained in a liquid state by a five or ten per cent. addition of either water or glycerine. No more fluid is to be used for dilution than is absolutely necessary, but liquefaction by heat will not answer. As soon as the carbolic acid has been introduced, it is diffused throughout the sac by freely shaking the scrotum. A sense of warmth is produced, which is quickly followed by a decided numbness. The patient may walk about and attend to his duties for twenty-four hours, after which he should keep quiet. No toxic effects have followed this injection.

At times *bleeding* follows immediately, or soon after the operation for hydrocele, and converts the case into one of hæmatocele.

A short time back I tapped the hydrocele of a man over seventy years of age, whom I had tapped periodically for fourteen years for the complaint. No mishap of any kind took place at the operation. The man remained quiet at his son's house for twenty-four hours, and then went home by tram-car, as he lived a short distance from London. I was requested in a few days to see him at his house, and found that he had been shivering and was feverish, with a dry tongue and quick pulse; he was restless in consequence of severe pain in the scrotum, which was much swollen, very red, and œdematous. I drew off with a somewhat large trocar and canula the contents of the swelling, which consisted of blood-stained fluid, soft blood-clots, and lymph. I then slit up the sac, which was much thickened, and like wash-leather in appearance, but rotten, as it gave way when a ligature was applied. The man attributed the accident to two violent jolts, which had caused acute pain in the part, received when riding home in the tram-car.

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[1] Lancet, vol. ii. 1877.

[2] Journ. de Méd. et de Chir. Prat., Décembre, 1871

[3] Trans. Med. Soc. Penn., 1881.

Suppuration of the sac of a hydrocele rarely occurs, but Mr. Dobson, of the Bristol General Hospital, met with a case after simple tapping.[1] Mr. Jessop,[2] surgeon to the Leeds General Infirmary, has recorded several cases of *sloughing of the scrotum* after tapping for hydrocele.

An out-patient aged 25 was tapped and sent home. Three days afterwards he said that he had had rigors, had lost his appetite, and was feverish. On admission, a gangrenous patch, the size of half-a-crown, was seen at the site of the puncture, and it was evident that the tunica vaginalis had suppurated; the sloughing spread, the whole of the scrotum was lost, and both testicles were exposed. Eventually granulations formed which drew down the skin of the abdomen and covered the testicles. A second case, that of a man aged 71, was not so fortunate, as in spite of stimulants and a generous diet he died of exhaustion from gangrene of the whole anterior part of the scrotum.

Sir A. Cooper states that he has known fatal *cellulitis* follow the injection of an irritating fluid into the cellular tissue instead of into the tunica vaginalis. Should such an accident happen, free incisions should be made. Baron Dupuytren was called upon to treat a case of this kind, in which the inflammation was very severe. M. Pelletan once saw *tetanus* ensue after the operation for hydrocele by injection.

(6) *Antiseptic incision* has been strongly recommended of late years for the radical cure of hydrocele by Prof. Volkman,[3] Prof. Lister,[4] and Mr. Jacobson.[5] It differs in its effect from the old operation of incision and the introduction of flour, lint, or other irritating substances, as it is unattended by any rise of temperature or constitutional disturbance, being free from suppuration. An anæsthetic having been given, the pubes and scrotum, which have already been shaved, are well washed with carbolic-acid lotion (1–20) or some other suitable antiseptic. The penis is also to be carefully washed. Several carbolized silk threads may be introduced through the skin and tunica vaginalis from side to side, and at some little distance apart, at the lower and front part of the swelling. An incision two inches long is then made over the threads, down to the tunica vaginalis, which is not opened until all bleeding vessels have been tied with fine carbolized catgut.[6] Having incised the tunica vaginalis for two inches, the silk threads are hooked out, and the surgeon then examines the interior of the sac to ascertain the condition of the testicle and the presence or absence of cysts or loose bodies, washes it out with the carbolic-acid solution, stitches the cut edges of the tunica vaginalis to those of the integument by means of the silk sutures already mentioned, and introduces a suitable drainage tube. If the sac be sclerosed, a small portion of it may be removed. The operation is to be done under the spray, but the wound may be dressed with any reliable antiseptic dressing. As carbolic acid is at times apt to produce local or general disturbance, eucalyptus gauze may be used, the first piece applied over the strip of protective having been dipped in the carbolic-acid lotion (1–20). The pleasant fragrance of the eucalyptus dressing shows that it is properly charged with the drug.[7] The penis is to be drawn through a hole cut in the middle of the dressing and its water-proof covering, taking care to stuff well the cleft between the thigh and the scrotum. The dressings are best kept in place by a double spica and a roller going in a figure-of-eight form between the upper parts of the

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[1] British Med. Journ., vol. ii. p. 43. 1872.

[2] Ibid., 1871.

[3] Berlin. klin. Woch., No. 3, 1876.

[4] Reported by Mr. J. Pollard (Brit. Med. Journ., June 25, 1881).

[5] Lancet, Sept. 1, 1877.

[6] Instead of cutting on the silk threads, two long threaded needles may be used, not being drawn through until the incision has been made on them.

[7] The sublimate gauze, but recently introduced to the notice of the profession by Sir J. Lister, is also a soft and comfortable dressing.

thighs, and by the use of the elastic bandage.[1] The operator may also, having applied the protective and a piece of eucalyptus gauze dipped in the carbolic-acid lotion, freely dust the part with iodoform, and envelop the scrotum in salicylic-acid wool; this makes a safe and comfortable dressing, as it keeps up pressure which expedites the cure. The patient leaves his bed in a week, but must use a suspensory bandage for some time; when the antiseptic dressings are left off, he may apply a piece of lint spread with boracic ointment; the antiseptic dressings have to be changed as often as the discharge soaks through. Total adhesion of the sac has been observed to take place, even when it lay in folds. In some of the cases reported, orchitis was present for the first few days after the operation.

The treatment of hydrocele by antiseptic incision is especially useful when the injection of iodine has failed; when the sac is very large and has very thick, cartilaginous or calcareous, walls, which do not collapse when the fluid is removed; when the hydrocele is congenital; or when it is necessary to explore for encysted hydrocele, cysts, or loose bodies.

Doubtless this is a safe and certain method of cure, but it requires for its performance the administration of an anæsthetic, and the use of special apparatus and dressings, and it is more likely to go wrong from indiscretion on the part of the patient, than is the operation by the injection of iodine. Patients who are too ill or too aged to be subjected to the treatment by injection, had better be contented with palliative measures. Stimulation of the tunica vaginalis by an *electric probe* or *electric needles* introduced into the sac, and the *sewing together* of the walls of the tunica vaginalis by sutures, have been recommended, but are unnecessarily severe methods.

After injection, adhesions may form, but are not necessary to a radical cure, as the balance between secretion and absorption may be restored without their presence.

INGUINAL HYDROCELE is the name given to a collection of fluid in the tunica vaginalis, when this incloses a testicle which has not descended into the scrotum but has remained in the inguinal canal. These cases are interesting from a diagnostic point of view, and are not common, since, in cases of retained testicle, the inguinal process of the tunica vaginalis generally communicates with the peritoneum. The swelling occupies the inguinal region, feels like a cyst, fluctuates, and is, in some instances, transparent. The scrotum on the affected side is empty, the testicle, which is small and undeveloped, being in the inguinal canal, where it can sometimes be felt in the swelling. These cases have been treated by incision, by injection, and by passing a seton through the sac. The best plan of treatment is, with antiseptic precautions, to make an incision into the sac, or to remove the testicle, which will often be found to have suffered a fibroid degeneration and to be devoid of the cells which secrete spermatozoa.

CONGENITAL HYDROCELE.—In cases of *congenital hydrocele* the inguinal process of the tunica vaginalis remains open, and the swelling fluctuates, is transparent, and has an impulse on coughing, owing to its passage up the inguinal canal; it is smaller in the morning than at night, and on making firm pressure on the swelling, the fluid is squeezed into the abdomen, but reappears, slowly or not according to the size of the opening, when the patient stands up, even though slight pressure be made on the external ring. On the reduction of the fluid into the abdomen, the testicle is felt. The *diagnosis* between congenital hydrocele and congenital hernia will be facilitated by remembering that in hydrocele there is dulness on percussion, and that the swelling disappears gradually on making firm pressure, unattended by any gurgling sound, descends slowly in spite of finger-pressure on the external ring, and does not come down suddenly when the patient cries or coughs. It is soft and perfectly even on the surface, and when distended with fluid feels fluctuant and is transparent. A congenital hernia, on the other hand, is resonant on percussion; when pressed upon, goes back at first slowly and then with a slip, often gurgling as it does so; is easily kept up by finger-pressure on the external ring, but forces its way downwards into the scrotum when the finger is removed and the patient cries or coughs.

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[1] See Vol. II. p. 73, Fig. 219, *supra.*

Mr. Curling[1] mentions two very rare cases of congenital hydrocele. In one the testicle was retained in the abdomen or canal, but the vaginal process of peritoneum contained fluid, being covered only by skin and superficial fascia. In the other a congenital hydrocele followed a late transition of the testicle, unaccompanied by a hernial descent.

Treatment.—Congenital hydrocele occurs generally in infants, but is met with occasionally in adults, and may be cured in them by the method of antiseptic incision—a plan which would not be suitable in the case of an infant, as the dressings could not be efficiently applied. The pressure of a truss, however, will cause a closure of the opening, and the fluid, which in all probability comes from the peritoneal cavity, will be absorbed. If it be thought desirable, when the case does not get well after the use of a truss, the canal can be closed by passing a carbolized catgut ligature subcutaneously around the funicular process of the tunica vaginalis. Many cases have been cured by tapping and injecting iodine, care having been taken to press on the external abdominal ring at the time of the operation. This plan seems to be devoid of danger. In this operation the tincture of iodine may commonly be allowed to flow out, but in some cases it has been found necessary to leave a portion behind. It is thought desirable to cure these cases, in order to prevent the possibility of a hernia forming, and also to avoid the occurrence of general peritonitis from inflammation spreading up along the tunica vaginalis, in consequence of inflammation of the testicle.

ENCYSTED HYDROCELE OF THE TESTICLE.—In these cases cysts are formed independently of the tunica vaginalis, and are associated with the epididymis or the body of the testicle. In the most common variety of encysted hydrocele, the cyst or cysts are associated with the epididymis, and are covered by the visceral layer of the tunica vaginalis, which is reflected over that part; two kinds have been described by M. Gosselin,[2] viz. (1) the small or subserous, and (2) the large or parenchymatous cysts. Cysts situated in front of the testicle itself, lying between and separating the tunica vaginalis and the tunica albuginea, are so rare as to be curiosities.

(1) The *subserous* or small cysts of the epididymis are transparent cysts placed in the subserous cellular tissue, and are unconnected with the efferent tubes; their contents are clear or milky, and contain no spermatozoa; at times they become pedunculated. They have been called the hydatids of Morgagni. They are common after forty years of age (Gosselin). An attempt has been made by Dr. Banks to associate these cysts with the ducts of Müller, traces of which are to be found in this situation; but they are common only in adult life, and never contain spermatozoa.

(2) The *parenchymatous* or large cysts are spermatic cysts developed in the neighborhood of the head of the epididymis, in the cellular tissue under the tunica vaginalis. They are lined with tesselated epithelium, are as a rule single, and are intimately related to the efferent tubes. The cyst enlarges,

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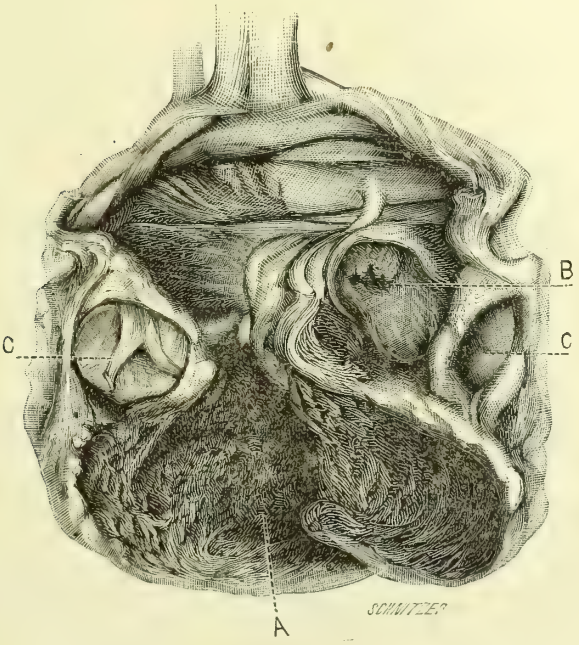
[1] Op. cit., p. 155.

[2] Arch. Gén. de Méd., 4ème sér., t. xvi.

and displaces the testicle downwards or to one side; the fluid is clear or milky, and when tested with heat and nitric acid becomes opalescent, instead of solid from coagulation of the albumen, as in cases of ordinary hydrocele fluid. When placed under the microscope, spermatozoa are at times found. This interesting fact was communicated to the profession simultaneously by Mr. Liston and Mr. Lloyd.

Fig. 1366.



Encysted hydrocele of the testicle, or spermatic hydrocele; the tunica vaginalis laid open, and the normal testis seen below.

On tapping a hydrocele for a man seventy years of age, I drew off five ounces of fluid, which was opalescent, and on examining some of the sediment under the microscope, I found a large number of well-formed active spermatozoa. Heat and nitric acid gave the fluid a milky appearance. Some months afterwards the old man reappeared, to have his hydrocele tapped again. I did the operation with especial care, and foretold the appearance of the fluid to be removed. I was disappointed, however, as on this occasion the fluid was straw-colored and contained no spermatozoa. It is possible that the original opening of an efferent duct into the cyst, had healed.

I have tapped on four or five occasions for another hearty old man, aged seventy-one, an encysted hydrocele of the testicle. The cyst, which has generally contained six ounces of fluid, is situated just above the testicle, which is to be seen or felt below it, and is incorporated and moves with it. The cyst fluctuates and is translucent. The fluid is milky, contains a trace of albumen, and, after having been kept on one occasion for eighteen hours, furnished many lively spermatozoa. Since the last operation, which was done without any mishap, the cyst has become rapidly swollen and painful, and inflammation with effusion has taken place, which will probably lead to a radical cure.

It has been suggested that the presence of spermatozoa is due to the wound of a duct in the performance of the operation. Sir James Paget has explained the presence of the spermatozoa in the cysts by saying that "certain cysts, seated near the organ which secretes semen, may possess the power of secreting a similar fluid." Mr. Curling, who has long worked at the subject, points out that the cysts are connected with the *excretory*, and not with the secretory portion of the organ, and that cysts developed in cellular tissue would not secrete fully developed spermatozoa. He also contends that the cysts are not formed, as some surgeons have supposed, from the dilatation of the seminal tubes, but are independent formations in the connective tissue between the efferent ducts and their investing membrane; and that the presence of spermatozoa is probably owing to the rupture of one of the tubes of the epididymis, and their escape into the hydrocele cyst. Spermatozoa are not discovered in small cysts, but in those of large size, into which they escape by rupture of the duct from a blow.

Dr. Menzel,[1] of Trieste, has described a case of spermatocele in which a direct communication with the testicle was proved to exist. When the latter was compressed, the cyst became distinct, and *vice versa.*

In the museum of the Royal College of Surgeons there is a preparation presented by Mr. Curling, showing the ducts of the epididymis ramifying over the cyst-wall; and an opening, through which a bristle is passed, is demonstrated passing from a duct to the cyst. The aperture is oval, and is evidently of some standing.

Mr. Bryant tapped, for a man aged sixty, three cystic hydroceles. The first two cysts contained spermatozoa, and a milky fluid, while the third yielded a clear fluid but no spermatozoa.

Encysted hydrocele of the testicle situated *between the tunica vaginalis and the tunica albuginea* is rarely met with.

A case is figured in Mr. Curling's work on diseases of the testicle, and the section of the testicle may be seen in the Hunterian Museum. The cyst, which is thick and dense, and which contained about two drachms of fluid, is situated in front of the testicle, which is depressed by it. Other cases are described by Mr. Hutchinson[2] and Sir B. Brodie.[3]

Symptoms.—The formation of an encysted hydrocele in the neighborhood of the epididymis is gradual and unattended with pain, and at times it ceases to grow. It is generally single, and does not attain to such a large size as a vaginal hydrocele, but is attached to the upper part of the testicle, which can be felt readily, and with which it moves. Its shape is irregular, its broadest part being at times from side to side; it fluctuates or not according to the tension of the sac, which when thick may prevent the transmission of light. The fluid is clear or milky, and may contain spermatozoa. The cysts are at times multilocular.

Treatment.—The best treatment for these cases is to inject the cysts with iodine, but they are liable to recur, and may require severer methods for their cure. They will generally yield to a seton, but I should myself prefer to open the cyst with antiseptic precautions, and to stitch its wall and the skin together with a few sutures.

DIFFUSED HYDROCELE OF THE CORD is a rare condition described by Pott and Scarpa. The sheath of the cord is thickened, and the cellular spaces of the connective tissue are distended with serum, which gives a sense of fluctuation; the swelling may extend upwards through the external ring. The testicle is felt in its normal situation, and the scrotum is not distended. This condition is to be diagnosed from hernia, all the symptoms of which, viz., impulse on coughing, disappearance of the swelling on lying down, the possibility of pushing up the hernia and the sensation communicated to the fingers as it slips back, the ability to feel the cord and to pass the finger into the inguinal canal and to feel its boundaries, are to be sought for. In cases of diffused hydrocele the cord is obscured, there is fluctuation, and a sensation as if a piece of omentum were present. An antiseptic incision, which is harmless, is the best way to clear up the diagnosis and to treat the case.

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[1] London Medical Record, 1877.

[2] Trans. Path. Soc. Lond., vol. vii.

[3] Lond. Med. and Phys. Journal, vol. lvi. p. 522.

ENCYSTED HYDROCELE OF THE CORD occurs sufficiently often to make its diagnosis and treatment of great consequence and interest to the surgeon. The swelling is oval and about the size of a marble, and feels very hard; it is evidently situated in the cord, the normal testicle being readily felt below, quite free from the cyst, and it being possible, as a rule, to pass the fingers above the cyst, between it and the abdominal ring, and to feel the cord of its normal size. If the cyst is in the upper part of the cord, it can be pushed into the abdomen, but returns as soon as the finger is removed—not gradually, as a hernia does, but suddenly shooting past the finger; when reduced it may be discovered tucked behind the abdominal wall by keeping a finger of one hand in the inguinal canal and feeling with the other hand on the surface of the abdomen.

A youth presented himself at King's College Hospital with a swelling the size of a walnut, just above the right testicle. The swelling had a distinct impulse when the boy coughed, disappeared when he was in bed, and was readily reduced into the abdomen, but could not be felt tucked behind the abdominal walls. It was, however, translucent and elastic, being too tense to give a characteristic sense of fluctuation; it could not be diminished in size by pressure, the cord could be felt above, and the testicle, free below, was not dragged upon when the swelling was reduced. The external ring was but slightly enlarged. The case was operated on by dissection, and an encysted hydrocele, connected with the cord, was removed. It had a longish pedicle, which so loosely attached it to the cord that it readily passed through the inguinal canal to a space in the fascia transversalis under the peritoneum, where it rested out of harm's way and beyond the reach of the surgeon's finger.

A young lad came to King's College Hospital with an encysted hydrocele of the right cord. Mr. Wood tapped it and injected some diluted tincture of iodine; as, however, the injection failed to cure, he dissected the small cyst out entire, doing the operation with Listerian precautions. The cyst looked like a small transparent bag filled with a golden fluid; its neck was long and about the size of a small probe. If this cyst had any communication with the funicular process, which is doubtful, it must have been very small.

In these cases, owing to a mistaken diagnosis, the patient often wears a truss. These cysts are formed in unobliterated portions of the inguinal process of the tunica vaginalis, and contain pale or straw-colored serum which is destitute of spermatozoa, unlike that from cysts found in relation with the epididymis. M. Giraldès has put forward the hypothesis that encysted hydrocele of the cord may be due to the dilatation of the cæcal tubes (*corps innominé*) which he says remain after the disappearance of the Wolffian body.

Treatment.—These cysts often subside, or remain stationary for years. They may be painted with the tincture of iodine, or acupuncture may be practised. If these methods fail, they should be injected with iodine, or incised antiseptically in the manner already described, or they may be dissected out. These cysts are more difficult to cure than hydroceles generally are, as their walls do not inflame and adhere as readily as serous membranes.

Mr. Syme[1] narrates the following instructive case of hydrocele of the cord: A man, aged 24, was said to have suffered from an enlargement of both testicles for two years. The swelling on the left side was due to an enlargement of the testicle, while that on the right consisted of fluid to more than half of its extent. The hydrocele could be diminished by pressure, and in making the patient take the horizontal posture, a well-defined oval tumor, obvious to sight and touch, ascended nearly to the umbilicus. When the two parts of the swelling were compressed alternately, a distinct fluctuation was perceived between them. On tapping the hydrocele, twenty-eight ounces of fluid were drawn off, and both parts of the cavity were emptied. The fluid reaccumulated in ten days. The operation was repeated, and three ounces of fluid were drawn off, when two drachms of the tincture of iodine were injected. The usual swelling and other symptoms of excitement followed for a few days; and, after they subsided, there was no return of the fluid. The hydrocele in this case occupied the cord and not the tunica vaginalis; since, in the latter situation, the fluid would have surrounded the testicle, instead of lying, as it did, entirely above it; and if the fluid had had access to the cavity of the peritoneum, it would not have been circumscribed within the limits of a distinct tumor.

CONGENITAL HYDROCELE OF THE SPERMATIC CORD is of rare occurrence, and is due to a patent condition of the funicular process of the tunica vaginalis. As a matter of fact, the portion which corresponds to the canal of Nuck, in the female, remains open above, being obliterated below, and allows fluid to pass backwards and forwards from the general cavity of the peritoneum into the cyst. The following case well illustrates the symptoms and treatment of the complaint:—

A post-office boy, aged 16, presented himself with a swelling about the size of a small walnut; it was smooth, transparent, elastic like a hydrocele, freely movable under the skin, and evidently connected with the cord, which was distinctly to be felt both above and below it. There was a vague impulse transmitted to it on coughing, but it was not the distensile impulse due to a hernia; the swelling became gradually less on pressure when the patient was lying down, and reappeared, but slowly, when he stood up; it became less after a night's rest. A puncture evacuated rather more than a teaspoonful of fluid, which was clear and devoid of spermatozoa. The boy had been told that he was suffering from a rupture, and that he was to wear a truss. I dissented from the diagnosis, but approved of the treatment recommended, which soon effected a cure without a repetition of the tapping. On first seeing the patient I considered the case to be one of ordinary encysted hydrocele of the cord; but my suspicions were aroused because of its reappearance in a few days after puncture, when, on more careful examination, I found that the swelling could be dispersed into the abdomen by steady pressure, and that as it disappeared a creaking sensation was felt. The channel of communication in this case was doubtless small, probably about the size of a small probe.

Mr. Furneaux Jordan[2] recommends for the cure of congenital hydrocele of the cord, pressure on the neck of the sac and injection of iodine; in cases of cystic hydrocele, he draws off the fluid by means of threads and then impregnates their ends with linimentum iodi. The same plan is also useful in the treatment of the small cysts with thin walls which collapse when tapped, and which are in consequence difficult to inject.

General Remarks on the Diagnosis of Hydrocele.—In the diagnosis between hydrocele and other scrotal swellings, we must bear in mind the symptoms which have been already pointed out as belonging to the former. In *hydrocele* the swelling is dull on percussion, translucent, tense, smooth, painless, and covered by healthy skin. The testis may only be discoverable by firm pressure, giving rise to testicular sensation. The spermatic cord, as a rule, can be readily felt above, and is free from pain or enlargement. The patient, if observant, states that the swelling commenced at the bottom of the scrotum, and, forming without pain, was of some size when it was first noticed. In some instances the testicle is to be distinctly seen and felt at the lower part of the scrotal swelling, just as in cases of hernia.

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[1] Contributions to the Pathology and Practice of Surgery, p. 302. 1848.
[2] Lancet, vol. ii. p. 537. 1877.

A *hernia* may appear suddenly, after a strain, and, commencing above in the abdomen, it forces its way down into the scrotum, travelling along the spermatic cord, which it obscures. When first noticed it is small, and returns into the abdomen at night. In congenital cases it fills the tunica vaginalis and obscures the testicle, but in ordinary non-congenital cases the testicle is readily seen and felt at the bottom of the scrotum, instead of being obscurely felt at the back part of the swelling, as in a case of hydrocele. The hernial swelling, if it contains intestine, is resonant on percussion; it is not transparent, and, if reducible, returns into the abdomen with a gurgling sound when manipulated. The abdominal rings become dilated, and readily admit the finger. The impulse on coughing, which is so characteristic of hernia, may be present in a hydrocele which runs up the cord ; it is, however, less strong and distensile. The diagnosis is sometimes difficult, but may be rendered clear by making an antiseptic incision or puncture into the swelling.

A *malignant tumor* of the testicle may resemble a hydrocele when the latter has very thick walls and its fluid is dark-colored. The tumor may be soft enough to give a sense of fluctuation, and there may be associated with it some fluid in the tunica vaginalis. A tumor grows continuously, and at times rapidly, occupies the situation of the testicle, and, if recent, may be painless, and the cord free from tenderness or swelling. The cord and inguinal glands eventually become enlarged. A solid tumor is believed by most surgeons to feel heavier than one formed of water ; but M. Nélaton strongly questions this belief. As a rule, the surface of a tumor will not be absolutely smooth, but will be irregular here and there ; besides, testicular sensation is lost. A large hydrocele will probably have the longer history, and a puncture will solve the question if it cannot be otherwise decided.

Complications of Hydrocele.—(1) A vaginal hydrocele is often associated with an encysted hydrocele of the testicle in the neighborhood of the epididymis. When the vaginal or larger hydrocele has been tapped, a cyst which fluctuates and is transparent remains behind ; the former yields a yellow, the latter a limpid or whitish fluid which at times contains spermatozoa. When a vaginal hydrocele has been tapped and injected without success, search must be made for a second cyst which is often the cause of the vaginal hydrocele, the size of which has masked its presence.

(2) A vaginal hydrocele may be associated with an encysted hydrocele of the cord ; the former is below the latter, and often separated from it by a well-marked constriction. The fluctuation in the two cysts is distinct.

(3) A vaginal hydrocele, when accompanied by a diffused hydrocele of the cord, would present a swelling of the tunica vaginalis below, and a distended, thickened condition of the cord which would prevent the ready introduction of the finger into the inguinal canal. Fluctuation would be felt independently in both swellings, and acupuncture or the introduction of Dr. Southey's trocars would disperse them.

(4) A hernia may be associated with a vaginal hydrocele ; this is not at all an uncommon combination. The hernia, which is not transparent, and which has an impulse on coughing, is situated at the upper part of the swelling, and has the hydrocele in front of it ; it may be reduced, and the hydrocele may then be treated in the ordinary way.

(5) A hernia may push its way down through an encysted hydrocele of the

cord. The testicle would be felt at the bottom of the scrotum, and, if an operation for strangulated hernia should become necessary, the hydrocele-sac would be cut into, a quantity of fluid discharged, and then the hernia would be sought for and found, still covered by a process of tunica vaginalis.[1] In the following case an encysted hydrocele of the cord coexisted with an irreducible omental hernia:—

A young man presented himself with an elastic, transparent swelling of the left spermatic cord, with no obvious impulse on coughing. A firm swelling could be felt running up the inguinal canal. An incision with antiseptic precautions was made into the hydrocele, which lay in front of the inguinal process of the tunica vaginalis, this remaining behind and still occupying the inguinal canal instead of collapsing. An incision was carefully made into the firm swelling, which was about the size of a ring-finger; the wall was thick, and contained a large mass of omentum, very tightly packed in the inguinal process of the tunica vaginalis. The omentum was ligatured in sections and removed, the sides of the hernial sac were brought together with catgut, and the sides of the inguinal canal were approximated with kangaroo tendon passed through both pillars of the external abdominal ring.

HYDROCELE OF THE HERNIAL SAC is apt to result after the radical cure of a hernia by the pressure of a truss, causing adhesion to take place between the sides of the neck of the sac, or between the latter and a piece of omentum. The cord would be obscured by the presence of a fluctuant swelling extending up the inguinal canal, receiving a transmitted impulse when the patient coughed. The swelling is said to be transparent, but, judging from the thickness of most hernial sacs, this symptom would not often assist the surgeon; the contained fluid is also dark-colored. The early history of the case—a hernia cured by a truss long worn—would be of great use if it could be obtained.

At Guy's Hospital,[2] a case of hydrocele of a hernial sac which simulated ordinary vaginal hydrocele, was treated by frequent tapping. An operation was done, and unfortunately an incarcerated bowel was opened; this was followed by peritonitis and death. The case was one of congenital irreducible hernia, with hydrocele of the hernial sac. The bowel was so changed in appearance that it was not recognized. There was no marked change in the muscular coat, but the serous and subserous coats were greatly hypertrophied and hardened. There was no resonance on percussion.

The best plan of treatment is, if the patient be of a suitable age, to dissect out with antiseptic precautions the sac of the hernia, tie its neck as high as possible, and bring the walls of the inguinal canal together with thick catgut ligatures.

A *spurious hydrocele* of the hernial sac ensues when a large quantity of fluid is associated with a hernia; a case of the kind may require an operation. The bowel and fluid may be returned into the abdomen, but both reappear when the finger compressing the ring is removed. The case may be one of congenital hernia. The operation for the radical cure of hernia may be done if the case be considered suitable.

A young man, who had been in the habit of wearing a truss for a hernia which was readily reducible, applied for assistance, finding one day that he could not reduce his rupture. He presented a medium-sized hernia in the right inguinal region, non-reducible, very tense, with no impulse on coughing, but with a sense of fluctuation and with some translucency. The diagnosis was an omental hernia with effusion into the hernial sac, and absence of impulse owing to excessive tension. Two drachms of yellow fluid were drawn off with a very fine trocar and canula, when the swelling, although it still remained irreducible, became less tense and the impulse on coughing was obvious. The hernia disappeared into the abdomen after twenty-four hours' rest in bed, and the application of ice to the swelling. Had the hernia remained irreducible, it was proposed to open the sac antiseptically, remove the omentum (tying its vessels), tie the neck of sac high up, and bring the sides of the inguinal canal together with catgut ligatures passed through its pillars.

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[1] Mr. Rivington (London Hospital Reports, vol. ii. p. 371) has reported a case in which a hernial sac containing ileum dipped down into a hydrocele of the cord, invaginating, as it were, the upper wall of the hydrocele.

[2] Med. Times and Gaz., vol. i. p. 617. 1878.

HÆMATOCELE.

Hæmatocele is present when blood is effused into the cavity of the tunica vaginalis, or into a cyst connected with the cord or testicle, and may be acute or chronic. *Non-traumatic or spontaneous hæmatocele* rarely occurs, and is so called because there is no history of a blow and no outward sign of extravasated blood. Sir B. Brodie[1] considered that the extravasation of blood was in these cases due to a diseased state of the bloodvessels, and that it was analogous to the extravasations met with in the lower extremities when their bloodvessels are unsound.

HÆMATOCELE OF THE TUNICA VAGINALIS may be simply due to the effusion of blood into a normal tunica vaginalis, or into one already distended by hydrocele fluid. In the great majority of cases, there is a history of a blow or wound of the part. The swelling forms very rapidly, is painful, and as a rule is associated with extravasation of blood into the cellular tissue of the scrotum, which is itself much swollen and discolored. Sometimes the enlargement is continuous.

In a case of hydrocele of the tunica vaginalis tapped the first time, the swelling was transparent, and the fluid drawn off was straw-colored; on the second occasion the swelling was no longer transparent, and, on tapping, the fluid removed was tinged with blood, which passed through the canula, mixed with the hydrocele fluid, and gave no more trouble. The man had received a blow on the part subsequent to the first operation.

Sir William Fergusson[2] relieved a hæmatocele by slitting open the swelling, in the case of a gentleman who was in the habit of performing acupuncture on himself for hydrocele, and who left a needle in the sac by misadventure.

Sometimes a rent is found in the tunica vaginalis, as in a case mentioned by Sir Astley Cooper. The following history of an old-standing hydrocele becoming converted into a hæmatocele by rupture of the thickened tunica vaginalis from what appears to be but a slight cause, is both interesting and instructive:—

The patient, H. E., aged 52, an intelligent man, made the following statement. He had had a swelling on the right side of the scrotum, about the size of a fowl's egg, and quite painless, for the last two years. Three days since he had been wheeling a heavy truck during the afternoon. He had gone to bed apparently quite well, but had awoke in the middle of the night with the sensation of something having dropped in his scrotum; having placed his hand on his hydrocele, he had found that it was increased twofold; at the same time there had been severe pain, which had continued more or less ever since. The right side of the scrotum, swollen to the size of a cocoanut, was œdematous and reddened in front. There was tenderness on pressure at the upper and outer part of the swelling, which was very heavy and elastic, with a distinct sense of fluctuation. The testis, however, was to be felt below and behind the swelling, apparently of normal size.

This being evidently a case of hæmatocele supervening on an ordinary vaginal hydrocele, and caused by the exertion of straining only, without any other injury, I laid the swelling freely open, using Listerian precautions, turned out a quantity of bloody fluid, blood-clots, and newly formed lymph, and discovered a very interesting pathological condition, viz., a *rent* in the thickened tunica vaginalis, which, instead of being shiny and transparent-looking, as in health, was opaque like ground glass. The surface exposed by the rent of the membrane was reticulated, as is well shown in the sketch (Fig. 1367) which was drawn by Mr. Crookshank, who assisted me at the operation. A few bleeding vessels in the cut scrotum, which was an inch thick, were tied with fine catgut; the edges of the incision were brought together; and a large India-rubber drainage tube was inserted, and was brought out at the lowest point. The man soon left the hospital convalescent.

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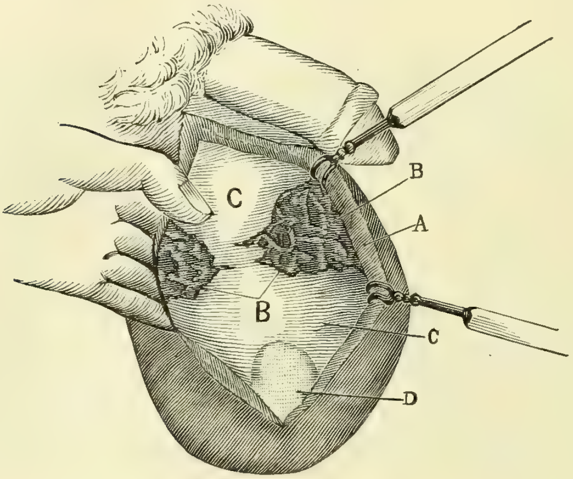
[1] London Med. Gaz., vol. xiii. p. 380.

[2] Lond. and Edin. Month. Journ. Med. Sci., July, 1843.

Fig. 1367.



Spontaneous hæmatocele from ruptured tunica vaginalis; *A*, coverings of testis enormously thickened; *B*, rent in tunica vaginalis (*C*), which was thickened and opaque like ground glass; *D*, normal testis covered by opaque tunica vaginalis.

In a case operated on by Mr. Henry Smith, at King's College Hospital, the hæmatocele followed immediately after the operation of tapping, which had been attended with hemorrhage. The tissues cut through to evacuate the fluid were two inches thick. In this case there was a good deal of inflammation of the scrotum, which was red, painful, and œdematous, and, if left, no doubt suppuration of the hæmatocele would have taken place. The testicle could not be discovered, although it was carefully sought for.

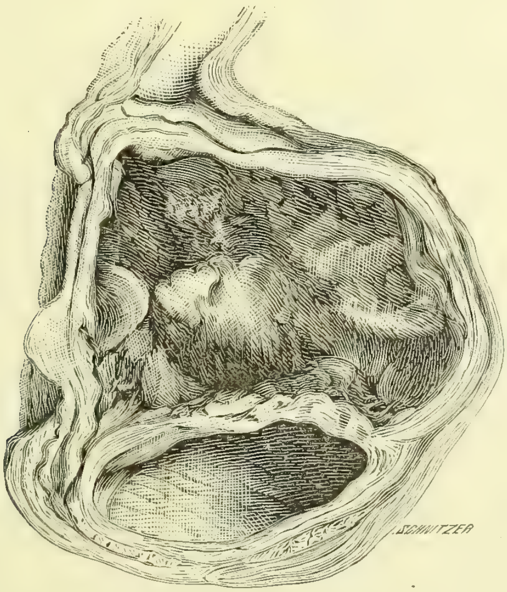
A hæmatocele may form in the tunica vaginalis of children after a blow, or from the wound of a vessel. If not evacuated, the blood sets up irritation, causes great inflammatory thickening of the part, and, after a few years, extreme difficulty of diagnosis, only to be cleared up by an incision which opens into a cavity and evacuates a quantity of decolorized coagula. M. Gosselin is of opinion that, owing to inflammation of the tunica vaginalis, which may be subacute and slight, false membranes form, supplied with bloodvessels which rupture and give rise to a hæmatocele; the exciting cause may be an orchitis, or a slight blow or squeeze. According to Sir James Paget, it may sometimes happen that lymph in the tunica vaginalis becoming vascular, and being submitted to even slight violence, its vessels may break and blood be poured into the sac, converting a hydrocele into a hæmatocele.[1]

Dr. J. Rochard gives the particulars of a case of hæmatocele of the tunica vaginalis which ascended through the inguinal canal into the cavity of the abdomen:—

> The scrotal portion of the tumor was oval, and reached downwards to the lower third of the thigh; it communicated by a cylindrical prolongation, in the course of the inguinal canal, with a second swelling within the cavity of the belly; this reached upwards to the navel, stretched to the right across the middle line, and lost itself at the bottom of the left iliac fossa. The patient, aged 51, had, six years before, had gonorrhœal epididymitis; he also had an inguinal rupture on the same side. The hæmatocele had begun suddenly, and was of nine months' duration. The treatment consisted in repeated tappings and injections of iodine.[2]

A hæmatocele is hard, dense, non-fluctuant; the scrotum is thickened, and gives a doughy feel; the tunica vaginalis is thickened and fibrous, and is filled with a dark, bloody fluid, portions of blood-clot, and layers of fibrin which are thick like wash-leather. The liquid contains red blood-corpuscles, fibrin, and blood-stained and swollen endothelial cells containing fatty granulations; crystals of cholesterin are also found in old cases.

Fig. 1368.



Old hæmatocele; tunica vaginalis thickened, and its cavity lined with fibrinous coagula, shreds of which project inwards; testis flattened and bound down by fibrinous deposit.

These cases, if chronic, are difficult to diagnose, if the history relating to an injury be deficient. There will generally, in recent cases, be discoloration of the parts; the swelling will have appeared suddenly, and will be excessive. An attempt must be made to ascertain the situation of the testicle, by making firm pressure on different parts of the swelling, which is generally œdematous. The surgeon must if possible trace down the cord to the testicle, which is usually a little below the middle, at the back part of the swelling. Sir B. Brodie reports the dissection of two cases of hæmatocele in which the spermatic cord was traced to the back of the swelling, where it became adherent to the surrounding parts, but in which the testicle was not to be found. Mr. Curling says that complete wasting of the gland is rare, and advises that great care be taken not to cut into it, as it may, when inverted, be situated in front of the swelling. Some observers believe that the compression of the testicle by the effusion causes it to waste, and to fail in the secretion of spermatozoa. The effused blood may remain quiescent, or may cause inflammation and suppuration. In hæmatoceles of long standing, the sac becomes very thick and even calcareous.

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[1] Op. cit., vol. i. p. 303.

[2] L'Union Médicale, 1861.

Treatment.—When the effusion is slight and there are no signs of constitutional disturbance, the patient should rest in bed, support the part on a pillow, and have leeches, cold lotion, or an ice-bag applied. The blood is slowly absorbed. If however the extravasation be extensive and progressive, with great pain and tension of the parts, the swelling should be freely laid open and the wound dressed antiseptically. In cases of hydrocele associated with hæmatocele, the fluid, if free from fibrin, will flow through a canula, and after repeated tappings the disease will be cured. If rapid swelling come on, attended with pain and fever, it will be necessary to lay the parts freely open, proceeding cautiously and tying every bleeding vessel. All the clots and fibrin should be turned out of the sac, which should be dressed lightly and not stuffed with lint. M. Gosselin advocates the removal of the sac. If the patient were an old man, it would be a safer operation to remove the whole of the tumor, sac and testicle. These cases should be treated antiseptically.

ENCYSTED HÆMATOCELE OF TESTICLE.—When effusion of blood takes place into a cyst situated in the neighborhood of the epididymis, an *encysted hæmatocele of the testicle* ensues. The diagnosis is not easy; the testicle is felt below the cyst, and is not obscured by it. There is generally a history of an injury to the part, or of the presence of a cyst, but this has often been so small that it has escaped the patient's notice. There will be a swelling, opaque and fluctuating, from which a trocar and canula will evacuate some blood-stained fluid.

HÆMATOCELE OF THE SPERMATIC CORD may be of the *diffused* or of the *encysted* variety.

The late Mr. Maunder[1] reported a case of extravasation of blood in the left spermatic cord which had come on during copulation; there was a good deal of ecchymosis, and it resembled the cases described as *diffused* hydrocele of the cord. If the hemorrhage be not progressive it will be absorbed under the use of stimulating lotions, but if the bleeding continue an incision will be necessary.

Encysted hæmatocele of the spermatic cord is caused by extravasation of blood into a cyst of the spermatic cord. There is a specimen in the Museum of the Royal College of Surgeons, of an encysted hæmatocele of the spermatic cord, which has above it a hernia, and below it a vaginal hydrocele. It but very rarely happens that an encysted hæmatocele of the cord is formed by an extravasation of blood into its cellular tissue becoming encysted. The swelling would be small and easily dispersed by an antiseptic incision.

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[1] Medical Times and Gazette, Oct. 1858, p. 413.

The following is a short account of Sir William Bowman's remarkable case of hæmatocele, which seems to have formed in the lower region of the cord and upper part of the epididymis, where encysted hydrocele of the epididymis occurs:—

A farmer, aged 60, was thrown from his horse and received a blow on the scrotum. A tumor appeared which occupied the left inguinal canal, was irreducible, without impulse or symptoms of strangulation, and was much ecchymosed. After the subsidence of the acute symptoms, a chronic swelling about the size of an egg remained. The inguinal glands never became enlarged. The tumor remained quiescent for six years, and then rapidly increased after exertion, from a fresh extravasation of blood. Fluctuation was so evident that it was twice punctured; the last operation set up acute symptoms, and the tumor became tympanitic and gave a splashing sound when shaken. It was of large size, reaching to the patella, oval in shape, and extremely heavy. Its neck ran up into the inguinal canal. The skin was dark-colored and covered with enormous veins; the mass felt solid, with here and there a doubtful sense of fluctuation. The contents of the hæmatocele filled two large washhand basins. The walls, which were universally adherent, were so thick that they did not collapse, and the patient was too weak to allow of the removal of the whole mass. The right testicle and tunica vaginalis, situated at the lower part of the scrotum, could be readily felt, and were free from adhesions.[1]

Early removal is indicated in these cases, as they show a tendency to increase, and but little to get well spontaneously.

Intra-testicular Hæmatocele.—MM. Cornil and Ranvier, with M. Cögne, have described two cases of hæmatocele of the testicle itself:—

There was a large, old-standing hæmatocele in the tunica vaginalis. In the centre of the testicle they discovered an old, partly decolorized clot, about the size of a small apple, which was traversed by thick-walled bloodvessels. Seminiferous tubes were implicated in the clot and spread out on its surface. The substance of the testicle in the immediate vicinity of the clot showed signs of inflammation, and exhibited a number of round embryonic cells.

M. Béraud[2] suggests that the bloodvessels arranged in a network on the testicular surface of the tunica albuginea, are liable when injured to give rise to a *parenchymatous hæmatocele*, and narrates two cases. The pain is very severe at the time of the accident, and persists for some time afterwards. The testicle remains swollen after the accompanying vaginal hæmatocele has been evacuated, and the tunica albuginea, presenting itself at the incision, eventually gives way and allows seminal tubules mixed with blood clot to protrude. An incision with strict antiseptic precautions should be made, in a case of this kind, if absolute rest, repeated punctures with a hydrocele-trocar, and the usual applications to procure absorption should fail.

VARICOCELE.

Varicocele, or *cirsocele*, is the term applied to a dilated and varicose condition of the spermatic veins, which become thickened, elongated, dilated, and very tortuous. It is a common complaint, usually attacking the left side. According to Sir A. Cooper, it hardly deserves the title of a disease, and in this opinion Sir James Paget agrees, as most cases are unattended by either pain or diminution of the virile powers. In some instances, however, the pain and mental worry caused by the swelling are excessive, rendering the patient unfit for work. At times the enlargement of the veins is enormous, as they may pass below the testicle and reach half way down the patient's thigh.

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[1] Medico-Chir. Trans., vol. xxxiii. p. 233.

[2] Arch. Gén. de Méd., 4e sér., t. xxv. p. 281.

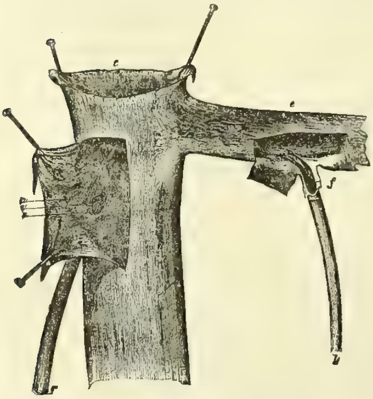
Anatomy of Varicocele.—Three sets of veins spring from the testicle: one from the rete and tubuli, another from the vascular layer of the tunica albuginea, and a third from the lower extremity of the vas deferens. Two of these quit the back of the testis; one at its anterior and upper part, and a second at its centre; and these, after passing on from two to three inches, become united into one. The other set accompanies the vas deferens, and there is also a large vein just above the testis, which crosses to join the three main columns. Mr. Curling analyzed 5639 cases of army recruits rejected for varicocele, and found that 344 suffered from varicocele on the right side, 4881 from varicocele on the left side, and 414 from double varicocele.

One reason commonly given for the prevalence of varicocele on the left side, is that the left vein, from its long course from the testicle to open into the left renal vein, has a heavy column of blood to support, and that it enters at right angles to that vein and to its current of blood. Again, the left testicle is heavier, and hangs lower than the right. Mr. Curling says that cases of varicocele are often associated with varicose veins of the lower extremities, or elsewhere. In the cases which I have examined I have very rarely found the combination mentioned, and, when it does exist, the varicocele is very large; it is to be noted, too, that varicose veins of the extremities are found in the middle-aged or old, whereas varicocele is commonly met with soon after the advent of puberty. The veins on both sides are pressed upon at the inguinal canals by the action of the abdominal muscles, whenever any violent muscular exertion is made, or when the patient coughs violently. The left vein is also pressed upon by a loaded colon. The right spermatic vein runs a shorter course than the left, as it opens into the inferior vena cava, entering the vessel in the direction of the circulation.

These various reasons are not satisfactory. Mr. Pearce Gould holds that varicocele is due, not to the yielding of the veins to internal pressure, but to venous hypertrophies; that the developmental stimulus of puberty is transferred from the testicle to the veins.

The American Journal of Medical Sciences, for July, 1856, contains an interesting communication by Dr. J. H. Brinton, of Philadelphia, demonstrating the existence of a valve at the termination of the right spermatic vein in the inferior vena cava, which acts as a most efficient safeguard against varicocele on the right side. He fully explains and illustrates the dissection necessary to display the valve.

Fig. 1369.



Dissection of vena cava, and of emulgent and spermatic veins, showing right spermatic valve. (After Brinton.)

It is just possible that the right inguinal canal is more capacious than the left, and that the right spermatic veins are less pressed upon in consequence.

Prunaire, as the result of twelve dissections, says that the right spermatic vein generally has a pair of valves at its opening into the vena cava; the left spermatic vein had a pair of valves at its opening into the renal vein in eight of the twelve instances; in the other four the valves were wanting, but were found three centimetres lower down. Another pair was found at the internal ring. Several existed between this point and the testicle on each side, so that in the course of the vein there were from six to eight pairs of valves.[1] Rivington[2] verified these observations, and noticed that when no valves existed either at the orifice or a little below the orifice of the left spermatic vein, valves were present in the renal vein within half an inch of the opening. A dissection for which I am indebted to Mr. Hugh Smith fully corroborates the above statements. Gray[1] states that a few valves are found in the spermatic veins, and one also at their point of junction with the renal vein or inferior vena cava in both sexes. The division of the right spermatic vein into several branches before it empties itself into the inferior vena cava, has also an important bearing on this question. This division and the presence of a valve are rendered necessary to stem the unbroken column of blood in the inferior vena cava.

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[1] Thèse de Strasbourg, 1851 (quoted by Sistach).

[2] Curling, op. cit.

Varicocele is most prevalent between the ages of fifteen and thirty-five, during the season of the greatest activity of the sexual organs, when they demand for the exercise of their function a free supply of blood; and it is said that the affection may result from excessive venery and masturbation. Exertions in which the abdominal muscles are called violently and suddenly into play, predispose to the disease, which is increased by much standing and by constipation. Mr. Maunder reported the case of a man who suffered from hæmatocele of the cord from rupture of a vessel during coition. The influence of varicocele on the nutrition and function of the gland is of much practical interest, and most surgeons are agreed that a wasting of the testicle takes place, and that it becomes softer when varicocele is present. Sir James Paget, however, doubts the production of these injurious effects. Sir A. Cooper, who considered that varicocele hardly deserved the name of a "disease," yet met with some cases which he thought justified the performance of a severe operation—excision of the scrotal tissues—for their relief. Mr. Key actually performed castration at the request of a patient who preferred parting with his testicle to enduring the pain caused by the disease. Sir William Fergusson cured a varicocele for a patient who requested him to remove the gland, by thrusting a red-hot awl into the varicose mass of veins. Varicocele is a very common complaint, but usually passes unnoticed, or at any rate untreated, as it commonly gives no pain. In many cases, patients complain of pain and discomfort only on the day succeeding sexual intercourse. There is no relation between the size of the tumor and the amount of pain experienced by the patient.

M. Gosselin says that, in the case of a man whose right testicle was useless owing to obliteration of the efferent duct, and who had varicocele of the left spermatic vein, no spermatozoa were found in the semen.

Mr. Curling reports the case of a man, aged 29, with double varicocele, who was moderately robust, and in whom both testicles were small and soft, who had occasionally strong sexual feelings and emissions, but whose semen was destitute of spermatozoa. In another case, a man aged 38, of weak sexual powers, had the right spermatic duct blocked after epididymitis and abscesses on the right side, followed by softening of the right testicle. He had a varicocele on the left side, and on this side the testicle was soft and flaccid. The fluid emitted in intercourse was destitute of spermatozoa.

Landouzy records a case of varicocele in an infant, and another in a child of seven; Bryant several cases which occurred before puberty, and one in a boy aged seven; and Pearce Gould the cases of a boy aged four and of one aged eleven.

The veins enlarge slowly and without pain, so that the varicocele is of some size before it is noticed. Eventually there is a sense of weight and uneasiness in the testicle and cord of the affected side; the dragging pain extends up to the loins, and is aggravated by standing for any length of time, or in a constrained position, and by violent muscular exertion. On stripping the patient, a flaccid condition of the scrotum is noticed, and the testicle hangs much lower than it ought to do, the veins of the scrotum being sometimes enlarged as well. In well-marked cases the veins may be seen like dilated cords occupying the region of the cord, and in bad cases they extend below the testicle. The dilated veins form a pyramidal tumor (*corpus pyramidale vel pampiniforme*), as they are convoluted below, but become less tortuous as they ascend to enter the inguinal canal. The tumor is soft and elastic to the touch, and the dilated veins are readily seen and felt; they can be rolled under the skin, and from their feel are usually compared to a bag of earth worms.

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[1] Anatomy, Descriptive and Surgical. London, 1858.

The size of the veins varies, diminishing when the patient lies down and dilating when he stands up; on coughing, the dilatation of the veins gives rise to an impulse, but to a gentle, not a forcible one like that communicated by a hernia. Some varicoceles remain permanently small and devoid of symptoms, but others give pain and may increase to a great size. The presence of a varicocele, which may be of trifling importance, often gives rise to much mental worry, and to an apprehension lest its possessor may become impotent. These fears become confirmed and exaggerated if the patient be unfortunate enough to fall into the hands of a quack. In some cases the pain is so severe that surgeons of note have been induced to remove the organ; severe pain is more likely to be observed in young than in aged patients.

A middle-aged man suffered acute pain for some days, owing to the recent protrusion of an inguinal hernia, on the left side, on which a varicocele had existed for some time without causing any distress. The pain was not relieved until a well-fitting truss was applied.

Diagnosis.—Varicocele has been mistaken for hernia, which it resembles in the following particulars: disappearance on lying down, increase on standing, and impulse on coughing. The feeling conveyed to the fingers by the varicose veins is very characteristic, as the impulse is slight, and attended often by a thrill given by the passing blood. The pyramidal shape of the swelling is characteristic, and most resembles a hernia which contains a piece of adherent omentum.

The test universally employed is the following: Place the patient on a couch, reduce the swelling, make firm but not excessive pressure on the external ring, and then make the patient stand up, still maintaining the pressure; in the case of a varicocele, since the spermatic artery conveys blood to the part freely past the finger, the veins will fill out to their full size. A hernia would be effectually retained by the pressure on the ring.

A congenital hydrocele disappears slowly on pressure, and returns slowly, is transparent, feels fluctuant, or is firm on pressure, and has a slight impulse on coughing.

It is a good plan in cases of varicocele and in other affections of these parts to examine the spermatic cords and testicle with *both* hands simultaneously. When the testicle is inverted the vas deferens runs along the front part of the cord.

Treatment of Varicocele.—The *palliative* treatment ordinarily recommended is support for the scrotum and testicles by a well-fitting suspensory bandage, the avoidance of warmth, which relaxes the parts, the use of a cold douche to the genitals night and morning, and the application of lint kept constantly wetted with muriate-of-ammonium lotion. Aperients are to be taken regularly to remove constipation, and tonics to improve the general health. Excessive venery is to be avoided.

Mr. Keitley strongly recommends a suspensory bandage devised by himself, which consists of a coarse network bag, and an India-rubber ring which presses on the veins.

Morgan's bandage, which is much in favor, is applied by lacing the testicle in a bag, which is then suspended by a strap passing from its base to a band buckled around the patient's body. The upper end, the smaller, is retained *in situ* by a piece of thick leaden wire stitched in it.

Mr. Wormald supported the testicle by drawing the lax skin of the scrotum through a soft silver ring covered with wash-leather, which was then made to squeeze the tissues. This is useful, and comfortable to the patient, as the ring is cooler than a suspensory bandage, and does not press on the bulb of the urethra.

Mr. Curling advocates, in some cases which are thought to be unsuitable for operation, the use of a Moc-main lever truss, which is to be applied before the patient gets up of a morning; the pad is arranged so as to make gentle pressure on the veins at the external abdominal ring. This method of treatment affords relief by pressure when the pain is neuralgic and the varicocele not excessive in size, but is not applicable to cases of great dilatation and thickening of the veins. The improvement is necessarily slow.

Radical Cure of Varicocele.—There are many methods in vogue for the radical cure of varicocele. That by *compression* is known as M. Breschet's method of operating, and is now seldom adopted.

It is done with two small steel forceps, with separated branches, which form segments of circles having teeth covered with linen, and which are brought together with a screw. The distended veins are separated from the vas deferens, and are compressed, together with a fold of scrotal skin, between the blades of the forceps. One pair of forceps is to be applied at the upper part of the varicocele, and the second pair about an inch below the first. The forceps are removed in twenty-four hours, when a hard, dry slough will be disclosed; this will come away, and the wound will soon heal. The veins are filled with coagulated blood, which in course of time becomes absorbed, the veins remaining obliterated.

Landouzy, by using a similar instrument, but hollowed out, preserves a bridge of skin along the free margin of the scrotum, between the eschars.

M. Maisonneuve treats varicocele by *injecting* from twenty to twenty-five drops of the tincture of the perchloride of iron with a hypodermic syringe. The veins are carefully compressed on their proximal side, so as to prevent any of the fluid from being carried into the circulation.[1]

The operation performed by the old surgeons and recommended by Celsus, was to *expose and tie the veins.* Sir A. Cooper discarded the operation because it was dangerous, being often attended by phlebitis and death. Sir B. Brodie also records disastrous consequences following this operation.[2]

Operation by Occlusion of Veins.—M. Davat, as an outcome of his experiments on animals, recommended the following operation:[3]—

A long steel harelip pin is to be passed between the vas deferens and the veins, and a soft silk thread is to be placed in figure-of-eight fashion around the projecting ends of the pin in front of the skin; the ends of the pin are then to be removed by wire nippers. The silk is twisted tight enough to prevent the circulation of blood through the veins; after a few days the coats of the latter are ulcerated through, and adhere together; the blood coagulates, and the presence of the pins causes inflammation, which produces an effusion of lymph at the part operated on, and a firm swelling, matting the parts together. When the pin has done its work, it is withdrawn.

Mr. Henry Lee formerly operated on varicocele by passing several pins under the veins, about an inch from one another, and applying figures-of-eight of soft, thick silk over their ends; this was the earliest improvement on Davat's operation, as he only passed one pin. Mr. Lee at first divided the veins subcutaneously between the pins on the third, and removed them on the fourth day, but afterwards divided them at the time of the operation. He now recommends the following procedure: the veins to be divided are temporarily isolated by acupressure; they are then cut through, and a portion of the skin removed. The cut surfaces are touched with the black-hot iron for about five seconds, and the wound is then sewed up with carbolized catgut.

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[1] Medical Times and Gazette, vol. i. 1878.

[2] Lond. Med. Gaz., vol. xiii. p. 379.

[3] Archives Gén. de Médecine, 2e série, t. xi. 1833.

Sir William Fergusson followed Mr. Lee's first plan of operating, introducing several needles, and twisting soft, thick, silk threads, in the form of figures-of-eight, around them. Mr. Henry Smith still operates in the same way; but to prevent undue ulceration of the skin by the pressure of the thick silk ligature, twists a narrow piece of lint over the pins before applying the figure-of-eight.

Mr. Curling operates in much the same manner, by passing two pins between the veins and the vas deferens, about three-quarters of an inch apart. The veins are then divided subcutaneously with a tenotomy knife, between the pins, which are shortened with wire nippers. Instead of allowing the thick soft silk which is twisted round the pins to be directly in contact with the skin, he interposes a piece of card-board, over which the silk is twisted, and so obviates cutaneous ulceration. A pad is applied, and the patient is kept in bed; on the sixth day the pins are removed. A hard lump, caused by the effusion of lymph, is felt for some time, but eventually becomes absorbed. The patient may leave his bed in ten days. The most common accident after the operation is an excess of inflammation, and the formation of a hydrocele. Suppuration sometimes takes place, and Mr. Lee has reported a case of hemorrhage.

The profession is indebted to M. Ricord for introducing the method of operating on varicocele by the *subcutaneous ligature*:—

Having isolated the veins from the vas deferens, which is behind, he passes a needle threaded with a double ligature between them, and withdraws the needle, leaving a loop projecting from the puncture, and a double thread which passes between the vas deferens and the veins; the needle is then again entered, armed with a double thread as before, at the point of exit of the loop, and, passing in front of the veins, between them and the skin, is brought out at the opening through which the ends emerge. The double ends are then passed through the loops, and drawn upon, while the loops sink into the tissues. Traction is kept up by means of a horse-shoe shaped *serre-nœud*.

Mr. Tufnell uses wire instead of thread to constrict the veins, and, to obviate the difficulty of withdrawing the wire passed in the manner recommended by M. Ricord, fastens other wires to the loops, to act as retractors. Wire is less absorbent and less irritating than thread, but is less readily manipulated; it is also less easily removed when it has done its work, and it is liable to break.

Vidal (de Cassis) devised the following operation, which is well spoken of by Mr. Erichsen:—

The veins to be obliterated are separated from the vas deferens, and an iron pin with two holes, one at each extremity, is then passed between them; next, a silver wire is passed subcutaneously by means of a needle in front of the veins, passing through the holes made by the pin; the ends of the wire are to be passed through the corresponding holes in the pin, by twisting which on its axis the wire is wound around the pin, and made to compress the veins between itself and the latter; the wire is to be tightened daily, until it has completely cut through the veins, which is accomplished in a week or ten days; the cure is aided by the formation of plastic material which helps to obliterate the veins.

Mr. Erichsen has dispensed with the pin, and contents himself with passing a wire subcutaneously around the veins; the loop is tightened as much as is deemed necessary by twisting the wire, which cuts through the veins, and causes consolidation of the tissues by the irritation set up.

An operation which requires to be repeated, as it were, daily, is faulty as a surgical proceeding, and is dreaded by the patient.

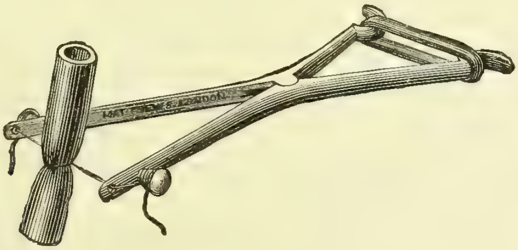
The late Mr. Partridge used to pass a silk ligature around the veins subcutaneously, with an ordinary stout suture-needle; the ends were then passed through two holes in two plates of a small silver instrument, and tied tight; the veins were divided by screwing the two plates apart by turning a small handle; this proceeding was very successful, but the screw had to be turned daily, and caused pain.

Mr. Messenger Bradley employs that form of acupressure known in the Aberdeen School as the method of retroclusion. A long and strong harelip pin is passed between the veins and the scrotal walls, its point being brought close beneath, but not through the scrotum; it is then made to retrace its course, but passing now behind the veins, until it emerges near the puncture through which it entered.[1] It is better to follow Mr. Osborne's example, and pass the pin first between the vas deferens and veins.

Mr. Wood's operation is done by passing a thin iron wire subcutaneously around the veins. The ends of the wire, which emerge at the same aperture, are passed through a large eye in the end of a steel rod about the size of a stout knitting-needle, which lies at right angles to its other end, an elongated, horseshoe-shaped spring of steel. The free end of the spring, which is provided with a projection, is then approximated to the rod, and the ends of the wire are securely twisted round the projection; the steel spring acts like a bow, and makes constant and equable traction on the veins until they are cut through; the wire may be left in until it has cut its way out, or may be removed when there is sufficient consolidation to obliterate the vessels.

To obviate the pain and ulceration caused by the direct pressure of the steel rod, I have devised the little instrument which is here figured:—

Fig. 1370.



Instrument for treatment of varicocele.

Having shaved the part, the surgeon passes a nævus needle with a large eye at its end, behind the veins, which are drawn forwards, away from the vas deferens; he then passes one end of a piece of carbolized silk through the eye of the needle, which is withdrawn, leaving a single thread behind the veins, and is next passed, without unthreading, subcutaneously in front of the veins; he now unthreads the needle, and passes the end of the thread which has just been removed around the free thread; the latter is then put through the eye of the needle, which is again withdrawn, and the thread disengaged from its eye; firm traction is made on the ends of the ligature, which are passed through the eyes of the small instrument, one thread through each eye, and are then fastened to the projections placed for that purpose. The arms come together, forming a St. Andrew's Cross by meeting at a central joint of the kind technically known as a circular joint. The traction is made by means of an India-rubber band twisted around the distal ends of the tractor; the force, which is regulated by the number of turns made with the elastic band, may be considerable, and is unremitting in its action.

The advantage of this instrument is that it makes traction on the threads, and pulls away from the veins and from the skin and tissues beneath; the openings through which the ligatures pass are small, and when these are removed they soon heal. There is no rule, in cases of varicocele, as to the time that the ligature should be left around the veins, as this depends upon the severity of the constriction, and upon the amount of veins and tissue included in the loop; in some cases the ligature may be removed on the fifth or sixth day.

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[1] Practitioner, London, vol. xx.

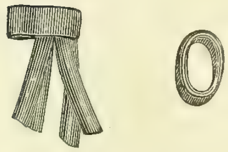
A patient, with a moderate-sized varicocele, had a double wire loop passed around the veins and the tractor applied; a good deal of consolidation took place about the double wire, which was removed on the ninth day; the patient then left his bedroom, and was able to go out of doors a fortnight after the operation. The extraction of the wires in this case was troublesome, and caused some sharp pain, as the effusion of lymph was abundant. I therefore now recommend the use of strong carbolized silk in preference.

The veins may be surrounded by a double wire of malleable iron. A stout sewing needle, with a large eye, may be used, and it will suffice to place the return-wires, which are to pass through the same openings in the skin, simply *between* and not around the double wires just passed.

The advantages of a subcutaneous operation, when a tractor is used, are, that the traction is continuous and, after an hour or two, painless, as no screwing up, which is very painful when the parts are inflamed, is required. No hemorrhage takes place, and after a week or ten days the veins are divided or blocked. The ligatures, whether of wire or of silk, are readily removed when they have done their work, and leave but a small wound, which soon heals; the consolidation along their track, which is advantageous, as it braces up the parts and prevents the veins from again dilating, in course of time disappears, but little or no trace of an operation remaining. In a few instances it has happened that, owing to great consolidation in its track, the wire has broken and remained in the wound; no bad consequences have followed, however, as the parts have healed soundly over the wire. It is better to pass the needle between the veins and the vas deferens when the patient is standing up, as then the parts are more obvious to the touch, and the number of veins diseased can be more accurately estimated. As a rule, an anæsthetic is desirable.

The *elastic ligature* has been used by me on several occasions, and may be applied in the following manner:—

Fig. 1371.



Elastic ligature and leaden clamp for treatment of varicocele; *B*, has cut its way out.

Having isolated the veins to be surrounded, I pass a hydrocele trocar and canula between the veins and the vas deferens, withdraw the trocar, and pass a piece of India-rubber cord of about the same size through the canula, which I then withdraw, leaving the cord in place. Re-introducing the trocar into the canula, I next pass it subcutaneously in front of the veins, pass the elastic cord through the distal end of the canula (free from the shoulder or stop-plate), and withdraw the latter, and finally pass the two ends, which emerge at the same hole in the skin, through a leaden loop, which is pushed well home by means of a pair of suitable forceps, and clamped on the elastic cord which is stretched as much as possible without breaking it. This operation is simple and very effective, as the loop cuts through the veins in a few days, leaving an ulcerated place the size of the leaden clamp.

Galvanic Cautery.—M. Amussat, having first carefully isolated the mass of veins forming the varicocele, from the vas deferens, surrounded them with a loop of platinum wire, the two ends of which were brought out through the same opening in the skin and placed in connection with a Middeldorpf's apparatus. In a few minutes the incandescent wire divided the vessels. Cotton-wool was applied as a dressing; the patient was well eighteen days after the operation, which was a very painful one.[1]

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[1] Gazette des Hôpitaux; Bull. Gén. de Thér., Juin, 1866.

The galvanic cautery is used by Mr. Pearce Gould, of the Middlesex Hospital, for the cure of varicocele. In all his cases the result has been admirable. The patient having been anæsthetized and the part shaved, Mr. Gould pinches up and separates the veins from the vas deferens, passes a long, narrow-bladed knife, with the side of its blade turned towards the veins, through the scrotum ; a platinum wire threaded on a needle is next passed along the track made by the knife, and afterwards in front of the veins, emerging at the point of its entrance. The ends of the wire are passed through the connecting tubes of a galvanic écraseur, and clamped. Connection is made with the battery, using sufficient cells to cause a faint hissing noise ; one cell of Grove's battery, or at most two, will be found sufficient. The wire is then drawn upon by the instrument, and made to cut its way slowly through the veins ; this it does in about five minutes. The skin about the point of exit of the wire is prevented from becoming much burnt by dropping a little water on the hot wire at this spot during the first part of the proceeding. This operation is attended with very little after-pain, and, when the patient is convalescent, a small hard nodule may be felt where the veins have been cut across. The patient is allowed to leave his bed in a week, by which time the wound has quite healed, a radical cure necessarily resulting.

The simplest form of subcutaneous operation is when a *ligature* is passed round the varicose veins under the skin. Since the introduction of antiseptics, *carbolized catgut* has been used. In some instances the veins have only been ligatured for forty-eight hours ; in others the ligature has been passed through holes in metal plates, and tied over an India-rubber tube, or simply to projections from the plates.

Mr. Barker[1] having washed the parts carefully with a solution of carbolic acid (1–20), and also the instruments and his hands, separates the varicose veins from the vas deferens, and, having notched the scrotum by passing a narrow knife behind the veins with the flat of its blade towards them, carries a needle armed with a double silk ligature, which has been soaked in the solution for one hour, first behind and then in front of the veins. Two loops of silk leave the scrotum at the same hole ; the ends are tied tightly about one-eighth of an inch apart, cut short, and allowed to drop into the scrotum. The part is dressed with salicylated wool. The swelling and after-pain are slight, and there is no suppuration, the wounds healing readily. The patients are in hospital for ten days or a fortnight. In one case, seen a year after the operation, the ligatures, which gave no pain, could be felt as hard knots deep in the scrotal tissues, which were normal.

Excision of Veins.—In order to effect a radical cure of the varicocele, and at the same time to avoid all risks of pyæmia, some surgeons have of late exposed and removed a portion of the varicose veins, operating with antiseptic precautions.

The part having been shaved and well disinfected by washing with carbolic acid lotion (1–20), an incision about two inches long is made over the prominent veins, midway between the external abdominal ring and the testicle. Having isolated the veins which it is intended to remove, the surgeon passes with an aneurism needle a double fine catgut ligature under them, and, having tied the veins in two places, removes the portion intervening between the ligatures, cuts the catgut off short, provides for the drainage, and having stitched the edges of the wound together, applies antiseptic dressings in the same manner as recommended after the antiseptic incision for the radical cure of hydrocele. The wound may be expected to heal in a few days, and after confinement to bed for a fortnight or so, the patient may be allowed to get up, wearing a suspensory bandage. In this operation, as in others on the veins, some induration lasts for several weeks, but will gradually become absorbed.

Mr. Howse[2] speaks in high terms of this method of operating, and narrates five cases thus treated with success. Mr. Jacobson[3] strongly recommends the operation, and gives the details of three cases. The first two were very satisfactory, but the third case unfortunately went wrong:—

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[1] Lancet, 1882.

[2] Guy's Hospital Reports, 1877.

[3] Holmes's System of Surgery, 3d ed., vol. iii. p. 571.

> The patient, a lad, had a double varicocele, that on the left side being of enormous size, the left half of the scrotum hanging three inches below that of the right side, and the dilated veins extending up to the external abdominal ring. Strict antiseptic precautions being adopted, the varicose veins were exposed and removed between double ligatures. Owing to the large size of the varicocele, three bundles of veins were removed, and even then a large number appeared to have been left, the tumor being about a quarter of its former size. Throughout the operation the vas deferens and the immediately surrounding tissues were held apart by a reliable assistant, and were not encroached upon. On the eighth day it became apparent that too many veins had been tied, as the lower half of the testis presented itself at the lower part of the wound, evidently in a state of gangrene; this was eventually removed, and the dressings were never foul; the temperature was rarely above 99° F., and no constitutional disturbance was present from first to last. This operation was carried out precisely as in the other two cases which had given excellent results; the vas deferens and the spermatic artery (which runs in its immediate vicinity) were certainly not interfered with. The testicle itself and the tunica vaginalis were not touched. Nor, as above stated, did it appear at the close of the operation that too many veins had been removed; such, however, must have been the case.

Surgeons are much indebted to Mr. Jacobson for his candid and lucid account of this case. I have not myself performed this operation, preferring the subcutaneous method, but from what I have seen of it in the practice of others, I consider that it is a more difficult and uncertain operation than that of subcutaneous ligature. It is hard to determine, as this case shows, the exact number of veins to be destroyed, as they are at the time collapsed. It is doubtless true that, as a rule, the spermatic artery runs with the vas deferens, and is removed from danger, yet if inversion of the testicle were present, or if the packet of vessels were twisted round and the neighboring parts disturbed, it might run a risk of being cut. In one case operated on by a skilful surgeon, hemorrhage occurred a few hours afterwards; much blood was extravasated into the cellular tissue, and the cure was delayed in consequence. After other methods accidents are rare, and the cure is complete and lasting. There would be less danger of removing too many veins if the surgeon were to isolate those selected for removal by passing a harelip pin or a short silver wire under them before proceeding to operate.

Excision of Scrotum.—Sir A. Cooper was in the habit of treating cases of varicocele by removing a portion of the scrotal skin from the affected side. An effort was made, by making a clean cut and bringing the margins of the wound accurately together, to obtain union by first intention. He reported some cases as having turned out favorably at the time; but several of them, when seen after the lapse of years by other surgeons, had relapsed. When we consider the repair that takes place after extensive sloughing of the scrotum, and the elasticity of its tissues, we cannot be surprised at the recurrence. The operation is uncertain, as primary union is of consequence, and does not always take place; and if suppuration follows, then pyæmia and other accidents are liable to occur.

The operation may now be performed antiseptically, suppuration prevented, and the chances of primary union rendered more certain. The requisite amount of skin is to be pinched up on the right or left side of the median raphe of the scrotum, as the case may be, and placed between the blades of a suitable clamp; all tissue in front of the clamp is then removed, bleeding points are carefully twisted or tied with fine carbolized catgut, and the margins of the wound are accurately brought together with numerous silver-wire sutures. The wound is then closed with a suitable antiseptic dressing, and the part carefully supported.

The most common reason for operating for varicocele, is to relieve the patient of a complaint, which, although of no great importance, is attended with a good deal of neuralgic pain, and which distracts his attention and causes more mental worry than its presence warrants. The case is often associated with spermatorrhœa, and the patient is distressed by the fear that he will become impotent. The disease is attended with softening of the testicle in some cases. A dislike to wear a truss or a suspensory bandage, which men find irksome, is an inducement to some to undergo an operation not in itself formidable, attended by little pain, and usually free from danger. As in operations on the veins of the legs, the radical treatment of varicocele may be practised in order to enable a man to enter the public service, or to follow some particular calling.

ANOMALIES OF THE TESTICLE.

ANOMALIES IN NUMBER OF TESTICLES.—Cases have been reported in which persons have been said to have *supernumerary* testicles, but they have not been verified by post-mortem examination, and the swellings have probably been due to the presence of hydroceles or tumors of various kinds.

In the Museum of St. Thomas's Hospital is preserved a supposed "third testicle" which was removed from the body of a physician; it is not a testicle, but a fibrous tumor. On post-mortem examination of a case, Blasius states that he found two testicles on the right side, which resembled in all respects the left testicle. An artery coming from the aorta went to each of them, and each had a vein which went to the vena cava.[1]

In some cases *one or both testicles are absent* from the scrotum; this may be due to the retention of the organ or organs in the abdominal cavity (cryptorchidism) or to their atrophy or congenital absence (anorchidism). In some cases the gland is absent, in others the gland and the epididymis, and in some there is no trace of the organ or of its vas deferens or vesicula seminalis.

Dr. Fisher, of Boston, has narrated[2] the case of a man who had no testicles, and whose cerebellum was abnormally small. Mr. Curling says that, in a case communicated to him by Mr. Page, of Carlisle, the sole testicle possessed by the man was hypertrophied.

A case is recorded by Geoffroy St. Hilaire in which the scrotum was bifid and empty; and the two suprarenal capsules, as well as the two kidneys and the two testicles, were joined together upon the middle line (synorchidism). The spermatic vessels, vesiculæ seminales, and vasa deferentia were normally situated. The child was registered as a female, and lived to be eighteen months old.[3]

The vas deferens may fail in becoming united to the testicle in some instances; in others it fails to communicate with the vesicula seminalis, or, communicating with the vesicula seminalis, does not enter the urethra; sometimes it is unattached at both ends. Sir James Paget[4] explains the fact that the testicle may be normal and the vas deferens abnormal, and the converse of this condition, by reference to the development of the parts. The testicle is developed independently of the apparatus which serves as the duct of the gland, and it is owing to this independent development that the testicle does not atrophy when its duct is defective, owing to disease, injury, or congenital malformation.

In 1823 Sir A. Cooper[5] divided the vas deferens on one side, and the spermatic artery and vein upon the other, in a dog. The testis, upon that side on which the artery and vein had been divided, sloughed away. The testis on the side upon which the duct was divided became somewhat larger than natural. The dog was kept for six years, during which time he was twice seen "in coitu," but the female did not produce. When he was killed, the vas deferens below its division was found to be extensively enlarged, full of semen, and entirely stopped, with some separation of its extremities; but it was open from the place of division to the urethra.

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[1] Obs. Med. Anat.

[2] American Journal of the Medical Sciences, O. S., vol. xxiii. p. 352.

[3] Hist. des Anomal. de l'Organisme, t. i. p. 542.

[4] London Medical Gazette, vol. xxviii. p. 818.

[5] Hunterian Museum, Specimen 2455.

When the vasa deferentia are divided, the animal develops sexual characteristics, but is sterile.

Imperfect Transition of the Testicle.—The testicle may be detained within the abdomen, in the inguinal canal, or just without the external ring in the groin; it is sometimes found also in the cruro-scrotal fold, the crural region, or in the perineum.

Mr. Curling believes that if the evolution of the testicle does not take place within twelve months after birth, it is rarely fully and perfectly completed afterwards, without being accompanied by rupture. In some cases the testicles do not reach the scrotum for a day or two after birth, and Hunter thought that this might occur as late as the tenth year; some think that it may be even as late as the twenty-fifth or thirty-fifth year.

The testicles are situated during the fœtal state within the abdomen, just below the kidneys, and begin their journey to their ultimate destination, the scrotum, about the fifth or sixth month, reaching the inguinal canal, which they traverse during the eighth month, about the seventh, and finally reaching the scrotum at the ninth month or after birth. A pouch of peritoneum, incomplete behind, where it admits the vessels, nerves, etc., to the testicle, descends with the gland and forms its tunica vaginalis, the communication of which with the general cavity of the peritoneum by the funicular process, which is analogous to the canal of Nuck in the female, becomes obliterated soon after birth, or, remaining pervious, permits the formation of a congenital hernia or congenital hydrocele. In some animals the canal remains open in the normal condition; it is, however, obliterated in the chimpanzee and the gorilla. Mr. Curling uses the word "transition" instead of "descent" of the testicle, as describing more accurately the process. The gubernaculum, which regulates the descent of the testicle, passes up behind the peritoneum in front of the psoas muscle, and is attached to the lower end of the testicle and of the epididymis and vas deferens. It then descends through the inguinal canal, and, dividing into three parts, is attached as follows: the external portion is attached to Poupart's ligament in the inguinal canal; the middle escapes at the external abdominal ring and is attached at the bottom of the scrotum, forming the mesorchium; the internal takes a direction inwards, and is attached to the os pubis and sheath of the rectus abdominis muscle.[1]

Causes of Detention of the Testicle.—Testicles fail to reach the scrotum in consequence of faulty contraction of the gubernaculum, which is paralyzed, or, as in a testicle in King's College Museum, removed by Mr. Wood to facilitate an operation for the radical cure of hernia, from peritoneal adhesions:—

The gubernaculum had failed to become attached to the lower part of the testicle, which was quite free and moved freely in the inguinal canal. The veins of the cord, which form the plexus pampiniformis, were seen lying comparatively loosely attached to the gland and to the surrounding parts. Owing to peritonitis, the testicle had become matted to the walls, or to the contents of the abdomen.

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[1] Dr. Bramann says that the first descent of the testicle is caused, and that the second and permanent descent is assisted, by pressure from the rapid development of the viscera behind it. He does not believe that the gubernaculum draws the testicle into the scrotum—first, because it is not inserted into that sac; and secondly, because its true contraction begins after the second descent has distinctly commenced and advanced. It is more probably the contraction of a layer of cellular tissue lying on the inner aspect of the gubernaculum, and distinctly connected with the tissues of the scrotum, that is the essential cause of the descent of the testicle. A fold of peritoneum forces itself downwards into the scrotum, and, preceding the testicle in its descent, pushes the well-known coverings of the adult testis before it. (Archiv für Anatomie und Physiologie, 1884; British Medical Journal, vol. ii. p. 1288. 1884.)

Mr. John Wood reports the case of a man, aged fifty, whose left testicle was detained in the abdomen by adhesions between its globus major and the mesenteric border of the sigmoid flexure of the colon, due to mesenteric disease in early life.

At times, the inguinal ring is too small to permit the passage of the testicle, whence its frequent detention in the inguinal canal. In a case under my care, the testicle just passes the external abdominal ring, and can be pressed back through the ring into the canal at pleasure.[1] This may not have been the original condition of things, but may have been due to dilatation of the ring by the growth of the testicle, and to a slight tendency to protrusion of the bowel, a not uncommon complication.

A large epididymis has in some instances caused a retention of the testicle in the inguinal canal. The gland is as a rule small, being undeveloped. In some cases the cord is twisted, but amply long enough to allow the testicle to pass into the scrotum; in others it is undoubtedly shorter than it ought to be, and helps to detain the organ in the inguinal canal. In several cases I have noted numerous well-formed bands of fibrous tissue passing from the pillars of the external abdominal ring to the testicle.

The left testicle is more often retained than the right; the tendency to this complaint may be hereditary, and in an example which has come under my observation, both father and son had one testicle retained in the inguinal canal; both had large families. Men suffering from retention of the testis on one side only, are, as a rule, free from other malformations, but when the defect is bilateral, it is apt to be associated with imperfect development of the penis and other parts.

We have now to consider the value of a retained testicle or testicles as organs of reproduction. Hunter held that when both glands were within the abdomen they were usually small and healthy, though imperfectly developed and useless as reproductive organs; but that some cases seemed to be exceptions to the rule. In some cases the individual is feminine, in others masculine, in appearance. Recent investigations with the microscope show that the semen is destitute of spermatozoa. In animals, as in men, retained testicles are small and soft, and their possessors are capable of unproductive intercourse. In cases of retention of one testicle, the patients are called *monorchids*, and have spermatozoa in the vesicula seminalis on the side of the descended testicle, but not on the defective side; such men can beget children. On the other hand, *cryptorchids*, who have both testicles retained, are always sterile.

Mr. Curling[2] has narrated the particulars of nine cases in which the ejaculated semen of men with retained testes—cryptorchids—or with a single retained testis, the other having been removed or its duct obstructed, was destitute of spermatozoa. In the few cases submitted to microscopic examination by myself, also, the semen has contained no spermatozoa. In a retained testis removed by Mr. Curling in operating for strangulated hernia, the scrapings from the body of the testicle contained cells undergoing metamorphosis into spermatozoa, and the fluid from the epididymis contained large numbers of spermatozoa in a quiescent state.

Dr. Beigel[3] has reported the case of a man aged 22, whose penis was well developed but whose scrotum was small and empty. In each of the inguinal canals a testicle could be distinctly felt, that on the left side being small but not wasted. He could have intercourse frequently and vigorously, and, when continent, had from time to time nocturnal emissions. A specimen of semen furnished by this patient showed, when examined under the microscope, a large number of spermatozoa to all appearances normal.

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[1] Trans. Path. Soc. London, vol. viii., p. 263.

[2] British and Foreign Medico-Chirurgical Review, April, 1864.

[3] Virchow's Archiv, Bd xxxviii. S. 144.

Godard holds that when both testicles are absent, the individual does not emit any semen, and that when both testicles are hidden, the patient, though not impotent, is sterile. The presence of one normal testicle in the scrotum is sufficient for the propagation of the species.

A powerful working man presented himself at King's College Hospital with both his testicles retained in the inguinal regions. On each side, a process of tunica vaginalis like the empty finger of a glove passed through the external abdominal ring. The right testicle was in the canal, the left passed readily backwards and forwards through the external ring. His sexual power caused him no anxiety; his emissions were copious, but no spermatozoa could be found on microscopic examination. He applied to be cured of a slight rupture on the left side, which could not be treated by truss-pressure owing to the presence of the testicle.

The microscopic appearances presented by an undescended testicle are seen in the illustration (Plate XXXV., Fig. 7), which shows a fibrous, thickened condition of the tubuli seminiferi, and a total want of development of the epithelial cells which elaborate the spermatozoa. An undescended testicle may be attacked by orchitis, attended with severe symptoms such as pain, swelling, vomiting, and constipation. If suppuration take place, the inflammation may extend to the peritoneum, and a fatal peritonitis may ensue. A testicle in the groin is very liable to injury from blows and muscular pressure.

Diagnosis.—As a rule these cases are easily diagnosed, as the scrotum is more or less undeveloped on the side or sides on which the testicle is wanting; if one testicle only be absent, and the penis be properly developed, it will appear to be larger than normal owing to the small size of the scrotum. An ordinary case resembles one of bubonocele, or one of encysted hydrocele of the cord. The swelling is hard, and shoots backwards and forwards, being easily pushed into the inguinal canal but reappearing as readily; in pressing the tumor, testicular pain is complained of, and the patient is often aware that there is something unusual in the formation of the parts. The impulse peculiar to a rupture is wanting unless a hernia be also present. When a retained testicle becomes the seat of inflammation, or of a morbid deposit, acute symptoms may arise, and the case may then much resemble one of strangulated hernia, as there is a good deal of pain, rendering the examination difficult and imperfect, with vomiting, constipation, and constitutional disturbance. There will still be the history to guide one, and the absence of the testicle on the painful side; the local symptoms may be more and the constitutional symptoms less severe than in cases of hernia; the bowels in such a case can be cleared by enemata, and an anodyne fomentation will relieve the local symptoms. An inflamed testicle in the groin is liable to be opened as a bubo, but a little care will prevent the error.

Mr. Jacobson[1] narrates the following successful case:—

The patient was aged 19, and had the left testicle retained in the groin. When fifteen months old a tumor appeared for the first time in the inguinal region, with sickness and syncope. The attack passed off, and he did not wear a truss. The swelling reappeared when he was 11, and he wore a truss from 14 years of age until a few days before his admission, when, not having seen a swelling for some years, he had left it off. When seen the pain was intense; a hard, defined swelling existed in the left groin, without impulse when the patient coughed. The abdomen was tense and full, and coils of distended intestine could be seen through the parietes. Constipation had existed for forty-eight hours, but there was no vomiting. Mr. Howse dissected down, with antiseptic precautions, and exposed a bluish encysted swelling with very vascular walls. On carefully puncturing this, it was found to contain a gangrenous testicle, which, on section, presented much the appearance of black currant-jelly, traversed here and there by a few unaltered septa and tubules. Another black cyst-like swelling with thinner walls, was found to be the epididymis, and above this was the reddish, pulpy, œdematous cord. This was divided after being tied with carbolized silk ; a few arteries were tied with catgut, and the wound was closed with wire sutures.

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[1] Holmes's System of Surgery, 3d ed., vol. iii. p. 471.

Treatment.—In some cases it is desirable to keep the testicle within the abdomen, out of harm's way, by means of a truss with a suitable pad. In children, however, should an inguinal hernia be present, the case should be left for a time to nature, in the hope that the bowel may push the testis past the external ring. Should the testicle at any time become acutely inflamed, the bowel is liable to become adherent to it and thus to be rendered irreducible.

In cases in which it is possible to manipulate the testicle downwards into the scrotum, giving room for the pad of a truss to be placed between the gland and the ring, this instrument may be worn, and will, if a hernia be present, keep it up in the abdomen. Mr. Curling recommends that if the testicle be undescended at the end of two years, it should be kept up by a truss. He removed a testicle which had been attacked repeatedly by inflammation owing to injurious compression by the abdominal muscles.

Mr. Wood's treatment of these cases is worthy of imitation :—

> In the case of a young man who had a retained testicle associated with congenital inguinal hernia, he removed the testicle, which was undeveloped, being half the size of the other, and then performed an operation for radical cure of the hernia by dissecting up the sac from the surrounding parts—or rather by tearing it, using two pairs of forceps, from its connection—then tying its neck high up with strong catgut and removing it. The edges of the external ring and the sides of the inguinal canal were brought together by passing silver wire through the external and internal pillars of the ring. In a case of strangulated hernia complicated with retained testicle, Mr. Wood performed three operations at one and the same time, viz., castration of a useless testicle, the relief of an acutely strangulated hernia, and its radical cure. This operation should be done with antiseptic precautions.

Prof. Humphry[1] says that, should a congenital hernia or one associated with a retained testicle become strangulated, the stricture will be found at the neck of the sac, and, it may be, at some distance behind the internal ring, a pouch, in which some of the hernia is contained, being formed between the peritoneum and the fascia transversalis. A hernia, instead of descending downwards, in these cases, turns upwards and outwards towards the iliac spine, owing to the undeveloped condition of the scrotum.

An interesting case in which a testicle was displaced into the perineum (*ectopia perinealis*) occurred to the late Mr. Partridge, who attempted but failed to replace it in the scrotum. (Fig. 1372.) A very full account is furnished by Mr. James Adams,[2] of the London Hospital, of the case of an infant aged eleven weeks, whose left testicle was similarly situated :—

> The cord and tunica vaginalis passed down in the fold between the scrotum and thigh; these, together with the testicle, were carefully dissected up and placed in a pouch prepared for them in the scrotum, where they were retained by means of catgut sutures passed through the lower part of the tunica vaginalis and the scrotum. The child died in fourteen days from erysipelas and inflammation carried along the funicular process to the peritoneum. In another case also, reported by Mr. Curling, the child died after the operation.

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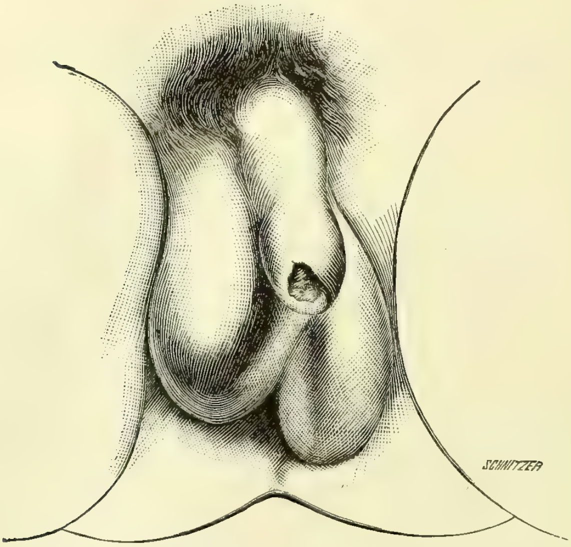
[1] Holmes's System of Surgery, 2d ed., vol. v. p. 78, note.

[2] Lancet, 1871.

Fig. 1372.



Misplaced testicle; the left side of the scrotum is empty, and the gland is in the perineum. (From Mr. Partridge's case.)

Professor Annandale[1] removed from the perineum the right testicle of a child aged three years, and placed it in the scrotum, where it remained, the operation proving successful:—

The incision extended from the external abdominal ring to half way down the scrotum, and exposed the cord, by means of which the testicle was drawn out from its abnormal position. Several adhesions were divided, notably a strong one, a process of the gubernaculum, which bound the lower end of the gland to the tuberosity of the ischium. A pouch was made in the scrotum to receive the testicle, which was securely fixed in its new position by means of a catgut stitch passed through its lower part and the bottom of the scrotum. Both the opening in the perineum and scrotum were carefully stitched up, free drainage being provided for. The operation was performed with antiseptic precautions.

A retained testicle is often attached to a shortened spermatic cord. When this condition is met with, Mr. Wood's ingenious device, which consists in carefully dissecting up the vas deferens and its accompanying vessels from the epididymis, turning as it were the testis upside down, and fastening it in its new position by means of a carbolized catgut ligature passed through what is to become the lowest part of the testicle and the scrotum, will be found valuable. The abdominal canal is closed by means of a thick carbolized catgut suture.

Mr. Wood recently shifted the left testicle of a lad from the inguinal canal where it gave a good deal of pain, to immediately outside the external abdominal ring, just within the confines of the scrotum, where, being free from muscular pressure, it ceased to give trouble.

In a case recorded by Mr. W. Roger Williams, a boy two years old presented a testicle situated in the perineum, acutely inflamed, and its tunica vaginalis, which contained fluid, perfectly formed and completely separated from the funicular process of peritoneum, which, however, was patent above that point and contained a hernial protrusion.[2]

[1] Brit. Med. Journ., vol. i. p. 7. 1879.

[2] Trans. Path. Soc. Lond., vol. xxxiv. p. 168.

It is a question whether an operation is advisable in very young patients. By waiting until they are older and stronger, while the testicle would be of much the same size, the funicular process of peritoneum would be more likely to be obliterated. Operations on the tissues about the pelvis for the rectification of malformations are attended with risk, and are better deferred for a few years, when, if considered desirable, they can be performed with antiseptic precautions, which cannot be employed with a child unless he be unusually manageable. In a case dissected by Mr. Ledwich he found spermatozoa in the testicle removed from the perineum. Mr. Partridge, however, failed to find them in his case. Mr. Hutchinson met with a case where both testicles were in the perineum.

The testicle at times makes its appearance in the thigh (*ectopia cruralis*), having passed through the crural canal. A careful examination will render the case clear, as an oval swelling the size of a testicle, situated just below Poupart's ligament in the situation of the crural ring, will be observed, and will be elastic, and, if inflamed, tender to the touch. The scrotum on the side corresponding to the tumor will not contain the testicle, and will probably be deficient in development. An endeavor should be made to return the testicle into the abdomen, where it should be retained by truss-pressure. A case of misplaced testicle may be associated with a hydrocele or a rupture, and in the latter case may be still further complicated by the bowel becoming strangulated.

RETRACTED TESTIS.—Retraction of the testicle is caused by spasmodic contraction of the cremaster muscle, and is either temporary or persistent. When due to disease of the kidney, to passage of a calculus along the ureter, or to prostatic irritation, the retraction is *temporary*, the spasm being sudden and confined to one side. Warm baths, sedative fomentations and suppositories, and especially the inhalation of chloroform, will relax the spasm and ease pain.

Persistent retraction is met with in children, and occurs on both sides, the testicle being drawn up as far as the external ring, or sometimes within the inguinal canal, or even into the abdomen (Godard). The testicle can be readily pressed into the scrotum, which is properly formed, though in cases of long standing it may be undeveloped. The cause of the retraction is not always apparent: urinary irritation, a kick on the pubes or in the groin, or a violent blow on the abdomen received when diving, has led to it. Cold baths, douches, and tonics are useful. The testicles should be manipulated daily into the scrotum, and retained there if possible with a Moc-main lever truss, with pads especially designed to meet the requirements of the case.

INVERSION AND REVERSION OF THE TESTIS.—The most interesting cases of *inversion* are those in which the epididymis runs along the anterior part of the gland, instead of the posterior. The free, convex, smooth surface of the gland presents posteriorly, and, in a case of hydrocele, the sac would be behind the testicle, which might, if care were not taken, be injured in tapping. Testicular sensation will demonstrate the presence of the gland at the front part of the swelling, the epididymis being felt in front instead of behind. The vas deferens runs in front of the constituents of the cord instead of behind, as in the normal state.[1] A testicle is said to suffer *reversion* when the head of the epididymis is situated below instead of above, the testicle being suspended by the tail of the epididymis.

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[1] Royet, De l'Inversion du Testicule, p. 34.

HYPERTROPHY AND ATROPHY OF THE TESTICLE.—The normal weight of the testicle is said to be six drachms by Curling, eight by Sir A. Cooper, and between six and eight, the left being slightly larger than the right, by Gray.

Hypertrophy of Testicle.—When one testicle is absent, that remaining in its place may enlarge.

In a case of the kind under the observation of Mr. Page, of Carlisle, the testicle in the scrotum weighed two ounces, two drachms, and two scruples. The organ was quite healthy in structure, and the epididymis was loaded with secretion.[1] In a case reported by Mr. John Wood,[2] the left testicle was in the iliac fossa, but the right was in the scrotum and normal in structure, though twice its natural size. In the case, however, of a lad whose left testicle wasted after acute orchitis following a blow, the sound testicle was of normal size only.

A young man consulted me about his right testicle. I found that the left testicle was represented by a small, hard body about the size of a pea; the constituents of the left spermatic cord were not nearly as well developed as usual; a body harder and more defined than the rest of the cord I took to be the vas deferens, and, if it was so, it was much smaller than usual. There was no history of any injury or disease of the part. The right testicle, about which he was anxious, thinking that it was diseased, was twice the normal size and much softer than usual to the touch. The scrotum was normal, but not quite as voluminous on the left side as on the right. From the history, and the want of development of the cord, I concluded that the defect on the left side was congenital; and that the right testicle was enlarged, but not diseased.

Atrophy.—In old age the testicles suffer from fatty degeneration and become atrophied, the vessels and tubes becoming contracted. An interesting specimen of arrested development of the testes and penis is preserved in the Museum of St. Thomas's Hospital:[3]—

The testes, which are exposed by dissection, are not larger than horse-beans, and the epididymis on each side is quite equal in bulk to the testis, its structure being apparently normal. Each vas deferens is about half its usual diameter in an adult. The penis is not larger than that of a child, and the scrotum of proportionate size. On the skin of the pubes there is only a small quantity of fine, light-colored hair. The specimen was furnished by a man aged fifty, whose voice was weak and effeminate; he had no hair on his face. He refused amputation for a compound fracture of leg, in consequence of the above-described condition of the genital organs which he wished to conceal.

In some instances the situation of the epididymis is occupied by a mass of fat, the vas deferens being blocked.

In other cases the testicles do not become developed at the time of puberty, but remain in the condition seen in the specimen above described; the tubes are imperfectly developed, and do not secrete spermatozoa. The individuals under these circumstances lack masculine attributes. Sometimes, where the testicles are undeveloped, the man can have intercourse, but does not beget children. It is stated on the authority of Wilson,[4] that a gentleman aged twenty-six, who had not experienced sexual desire until he met his wife, and whose penis and testicles about equalled in size those of a lad of eight years of age, married and begot children, his testicles becoming in a couple of years of the normal size.

Wasting of the testes has been met with in cretins and idiots, after injuries to the head in the occipital region, after fractures and contusions of the spine, and in some instances where the cause has not been very obvious.

Mr. B. Travers presented to St. Thomas's Hospital Museum, a specimen illustrating the cure of a lipoma by pressure; the epididymis was obliterated, and the testicle was atrophied.

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[1] Curling, op. cit., p. 63.

[2] Trans. Path. Soc. Lond., vol. viii. p. 562.

[3] St. Thomas's Hospital Museum Catalogue, 1859. Section E. E.

[4] Lectures on the Urinary and Genital Organs.

As we have already seen, a blocking of the spermatic artery, either by section or by ligature, will cause the testicle to waste. An aneurism of the aorta, pressing on the spermatic arteries at their origin, caused wasting of both testes. In varicocele, the circulation of the testicle being impaired owing to a faulty condition of the veins, the gland is softer and smaller on the affected side, being according to Mr. Pearce Gould undeveloped, and not atrophied. In some cases the testicle is wasted owing to its compression by a hæmatocele or a hydrocele. Faulty truss-pressure will also cause atrophy. Sir Benjamin Brodie, in a lecture on varicose veins, says that, in conformity with a general law of the animal economy, a part not used wastes. Most observers, however, are agreed that the testicles do not waste in men who are continent, and we have already seen that the testicle does not become smaller when the vas deferens, its duct, is destroyed. Sir James Paget has noted the interesting fact that if a buck be castrated when his antlers are in the velt, they remain velvety and eventually become small and ill-formed.

It is probable that testicles which are unused do not develop like those that are used with moderation, and that they cease to be functionally active at an earlier age. In cases of epispadia and hypospadia, the testicles, when present, are smaller than usual. In paraplegia, following injury to the cord from fracture or dislocation of the spine, the testicles waste and do not secrete spermatozoa, according to the testimony of Curling, Klebs, Wardrop, and others. These cases are associated with fatty degeneration of the gland, absence of spermatozoa, and cessation of sexual desire. The epithelium lining the seminal ducts, and the epithelioid lining of the bloodvessels of the testicle, in patients suffering from typhus fever and other diseases attended by high temperature, undergo a fatty metamorphosis.

The substance of the testicle becomes disorganized by the pressure caused by new growths within the tunica albuginea.

Acute orchitis, whether consequent on disease, especially mumps, or on injury, often leads to atrophy so complete, that only two fibrous nodules remain to mark the former situation of the testis and epididymis. The specimens illustrating testicular atrophy in the Museum of the Royal College of Surgeons, almost all exhibit marks of inflammation of some kind, with adhesions of the tunica vaginalis or with effusion of lymph. Sir B. Brodie referred the wasting of the testicle in one case to masturbation, and in another to inflammation from sexual excitment. Elephantiasis Græcorum has been said by Lawrence, Curling, and others, to give rise to atrophy of the testicles.[1] A severe contusion will so injure the gland as to cause it to waste, and men and animals have been purposely rendered impotent by crushing their testicles. A wound of the tunica albuginea may allow the tubules to escape and may thus destroy the gland. The assertion that iodine and its compounds cause wasting of the testicles needs confirmation.

Venereal excesses and masturbation injure the organ by causing attacks of subacute inflammation. A syphilitic orchitis, when left without suitable treatment, will destroy the gland.

Anœmia of the testis may be associated with atrophy, or the gland may retain its usual size, but present a very pale appearance on section. Spermatozoa are no longer produced. A debilitating illness may induce anæmia of both organs, but generally one only is affected in cases of tubercular and syphilitic sarcocele, and when new growths displace the secreting structure. The false membranes so frequently found after inflammation of the tunica vaginalis are, according to M. Gosselin, very vascular, and flourish at the expense of the blood-supply of the testicle.

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[1] Medico-Chir. Trans., vol. vi. p. 214; Medical Gaz., vol. vii. p. 447; Sir Erasmus Wilson, Lectures on Dermatology, Royal College of Surgeons, 1873.

AFFECTIONS OF THE VAS DEFERENS, VESICULE SEMINALIS, AND EJACULATORY DUCT.

AFFECTIONS OF THE VAS DEFERENS.—Mr. John Birkett, in his article on injuries of the pelvis in Mr. Holmes's *System of Surgery*,[1] quotes three cases of *rupture of the vas deferens* which occurred in the practice of the late Mr. Hilton, who considered that the duct was ruptured between the internal ring and the point where it crossed the ureter. Blood flowing from the artery of the part, finds its way along the vas deferens to the prostatic urethra. A catheter when passed into the bladder draws off clear urine, although there is bleeding from the canal. Mr. Hilton made a post-mortem examination in a case where there was rupture of the vas deferens at the point above mentioned, and atrophy of the testicle. Both ends of the vas deferens were separated and closed. The symptoms of the accident are said by Mr. Hilton to be sudden and violent pain, after severe exertion or a blow, and flow of arterial blood from the urethra, the urine when drawn off from the bladder being clear. There are at first swelling and tenderness of the testicles, which may eventually atrophy. There are also tenderness of the lower part of the abdomen, and pyrexia. The treatment is the same as for contusion of the testicle and for orchitis, viz., rest in bed, support of the testicles by a pillow, leeches, fomentations, and aperients.

In cases of division of the vas deferens by a *wound*, the surgeon should bring the ends of the injured duct together with fine catgut sutures. Neuralgia of the testicle has been so severe after a rupture of the vas deferens that castration has been resorted to.[2]

Abscesses but rarely form in the vas deferens.

A patient under Mr. Hutchinson's care was attacked, after lithotrity, by double orchitis, with a collection of stinking pus in the tunica vaginalis on both sides. A succession of abscesses, which no doubt originated in the inflamed vasa deferentia, formed in the abdominal wall in each iliac region, beginning with deep-seated pain, swelling, and induration, and were evacuated by deep incisions. The symptoms, which were severe, and, like those of pyæmia, subsided after the removal, by lateral lithotomy, of a sharp fragment of stone, which was impacted in the prostatic urethra.[3]

INFLAMMATION OF A VESICULA SEMINALIS may sometimes follow urethral irritation, such as that caused by stricture. Micturition is frequent and painful, and semen may be discharged with the urine, and occasionally with a motion. The vesicula seminalis is tender on pressure through the rectum, and pain is felt on both sides at the fundus of the bladder, on making deep pressure on the abdominal walls.

A young man under Mr. Mitchell Henry's care[4] suffered from pain in the loins and hip-joint. He walked like a person suffering from morbus coxarius; but the hip-joint was sound. The urine, which caused a burning pain when passed, contained pus, and eventually blood. He suffered from very severe constitutional disturbance, with a tender and tympanitic abdomen. A post-mortem examination showed that the left vesicula seminalis had been converted into a large abscess, which had perforated the bladder by a small round hole, just where the reflection of the peritoneum took place; the pus, having found its way into the peritoneum, had caused a fatal peritonitis.

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[1] Op. cit., 2d ed., vol. ii. p. 739.

[2] P H Watson, Edinburgh Med. Journ., 1866.

[3] Medical Times and Gazette, vol. i. p. 420 1871.

[4] Medico-Chir. Trans., vol. xxxiii. p. 233.

Mr. Cock's case had a more fortunate termination. The man had deep-seated pain in the lower part of his belly, radiating to the hip-joint on the left side. The symptoms increased in severity, with fever, pain in passing water, and tenesmus. Mr. Cock detected a fulness just above and to the left of the prostate, with an obscure sense of fluctuation. A puncture through the rectum liberated some thin, dark, offensive pus.

These cases are to be treated by fomentations and sedatives, but especially by a timely incision.

Cysts of the vesiculæ seminales occasionally form, and may grow to a large size. They grow so slowly[1] and insidiously that they are likely to escape detection. Fluctuation may be perceived by a finger introduced into the rectum, when deep pressure is made on the abdomen.

AFFECTIONS OF EJACULATORY DUCTS.—M. Reliquet[2] reports a case of spermatic colic on the left side, caused by obstruction of the left ejaculatory duct:—

A young man suffered for twelve months from symptoms resembling those of vesical calculus and prostatic enlargement. There were painful spasms in the region of the bladder, and severe pain during defecation and coitus. The pain and spasms were intensified by pressure on the vesicula seminalis with a finger introduced into the rectum. There was no stone in the bladder, and, on withdrawing the instrument used in the examination, a violent spasm ensued, accompanied by the passage of urine, and by the discharge of forty small opaque white bodies, about the size of a pin's head or a lentil. The concretions were facetted, with blunt angles, like prostatic calculi, and were soft like putty, presenting under the microscope parallel rectilinear striæ, and spermatozoa, which were rolled together. After their discharge, all the morbid symptoms subsided.

SPERMATOCELE.

Spermatocele is the term applied to a tumor which is formed by a collection of seminal fluid, and Mr. Curling objects to the same term being applied to encysted hydrocele of the testicle. It is, he says,[3] possible that the semen might collect in and dilate one or more of the seminiferous ducts in the body of the testicle, in consequence of some obstruction, and thereby constitute a swelling of a similar character to the lacteal tumor of the breast; but he has not met with a single instance of the kind.

In cases of obliteration of the vas deferens the semen is retained, and, its watery constituents becoming absorbed, the inspissated semen that remains forms small depots of soft material which block up the seminal tubes. The material below the obstruction is composed of cells filled with spermatic filaments, calcareous granules, and cells in different stages of fatty degeneration.

According to Breschet's[4] over-drawn description, spermatocele is a swelling of the spermatic cord, and especially of the epididymis, depending on the retention of semen. If the secretion be not voided, inflammation, bursting of the swelling, and actual fistula ensue. He says that gonorrhœal epididymitis depends on the retention of semen, and recommends moderate diet, cold lotions, and leeches if necessary.

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[1] C. H. Ralfe, Lancet, vol. ii. p. 782. 1876

[2] Gaz. des Hôp., 3 Sept. 1873.

[3] Op. cit., p. 412.

[4] Observations et Réflexions sur la Fistule spermatique ou Spermatocèle, Journal Général de Médecine, Juin, 1826, p. 348.

South[1] writes that spermatocele is often a sore nuisance to young people; the testicle becomes so exceedingly tender that the mere pressure of the dress upon it causes pain. It is not followed by fistula, but it recurs at intervals of two or three months. The patient should rest and support the parts, and should apply cooling lotions. The disposition to the affection ceases after a time.

Neuroses of the Testicle.

The nervous affections of the testis which require notice are the *irritable testicle*, in which the parts are so sensitive that the least touch gives pain, and *neuralgia of the testicle*, in which the pain is more deeply seated, and, passing upwards along the spermatic nerves to the groin, gives rise to a neuralgic condition. The former is apt to come on after abuse of the sexual organs, and in young men with active sexual organs and inability to exercise them. In cases of debility, in which the patients are addicted to masturbation or are liable to seminal emissions, the parts must be soothed by the local application of sedatives, such as aconite liniment or belladonna plaster, and protected by means of a well-lined suspensory bandage. The passage of a full-sized sound will lessen the over-sensitiveness of the prostatic urethra. The diet and the state of the bowels must be carefully regulated, and then tonics, suitable to the individual case, may be given. The parts should be well douched with cold water; exercise and sea-bathing are also beneficial. If a varicocele be present, it must be treated according to its severity. The disease is not inflammatory, and a careful examination of the testicle, when removed, has failed to discover any morbid change. In the Hunterian Museum (Specimen 2440) is a testicle which was extirpated because it had been for many years the seat of the most severe pain. There is now no discernible change in its structure, but when first examined a small quantity of pus was found in the epididymis. Sir A. Cooper states that he was thrice compelled, solely at the request of the patients, to remove their testicles because of irritability. The pain varies in character; it may be a numb, pricking pain like that caused by pressure on a nerve, and is much increased by handling the part. Sometimes the pain is relieved for the time by an emission, but returns with increased severity. In *neuralgia of the testis* the attacks come on at any time, coming and going in a capricious manner, as in neuralgia in other parts of the body. The pain may be very severe, and cause retraction of the organ, but it is not superficial as in irritable testicle, and the part can be handled without pain, though swollen. Severe pain and retraction of the testicle, accompanied by vomiting, an irritable condition of the bladder, and intense pain along the spermatic vessels and nerves, are met with when a renal calculus is passed. Indigestion and gout often distress the patient. General remedies, such as aperients, nerve-tonics, and sedatives, must be given; the latter are the most important—such drugs as cannabis indica, chloral, and bromide of potassium, in full doses. Locally, opium, conium, belladonna, chloroform, or menthol, either singly or in combination, may be applied. An ointment containing the muriate or acetate of morphia (gr. v–℥j) or aconitia (gr. j–ʒj) may be smeared on the cord twice a day (Curling). In some instances blisters prove useful; in all, evaporating lotions, or, still better, ice, may be applied. Castration is not to be recommended, although it has been done in certain cases.

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[1] Chelius's Surgery, vol. ii. p. 295.

INJURIES OF THE TESTICLE.

WOUNDS OF THE TESTICLES are not frequent, as the glands, contained in their tunicæ vaginales, are loosely suspended at different levels, and so movable that they elude injury. *Punctured wounds* are generally caused by the surgeon accidentally wounding the testicle with a trocar or lancet when evacuating a hydrocele. The pain, sharp for a moment, soon passes off, the puncture generally causes no after-trouble, and the effused blood becomes absorbed; occasionally, however, a hæmatocele or inflammation of the testicle ensues. The patient should rest, take an aperient, and apply pressure and a bag of ice.

A wound from a *cutting instrument*, when of any size, is dangerous, as the tubuli seminiferi are apt to protrude. The thread-like protrusions must not be touched, as they might be readily drawn out. The wound should be stitched carefully with fine catgut over the tubes. If inflammation supervene, the whole of the secreting structure of the testicle may suppurate or slough out.

Contused wounds are of serious import, as the subsequent inflammation is intense, and leads to sloughing of the gland and its coverings. When the testicle is *lacerated* to such an extent that it is past recovery, it should be removed at once. In the King's College Museum is an interesting specimen, removed by operation from a man who had met with a severe accident. The lower two-thirds of the secreting structure of the testicle are seen to have been forcibly squeezed out of the ruptured tunica albuginea, which is gathered in folds at the upper third of the gland. At the lower part the tubuli seminiferi are seen as dark, blood-stained shreds, and at the upper part the outlines of the lobules are distinct.

CONTUSIONS OF THE TESTICLE cause extravasation of blood into the cellular tissue of the scrotum, and the parts become of a dark purple color. The pain from testicular contusion is excruciating; the skin becomes pale and clammy; the patient vomits, and often faints away, and may sometimes even die from shock. The local symptoms may subside under cold applications; or inflammation, followed by suppuration or atrophy, may result.

Hæmatocele of the testicle, caused by an effusion of blood under the tunica albuginea, sometimes follows a blow.

ORCHITIS.

Orchitis is the term applied to acute or chronic inflammation of the testicle, generally associated with inflammation of the epididymis or tunica vaginalis. In the majority of cases it is the epididymis that is attacked, and that causes the greater bulk of the swelling; *epididymitis* or *hernia humoralis* is then said to be present. The greater number of swelled testicles which come under our notice are due to gonorrhœa, or to some irritation of the urethra, the epididymis being the part affected; but orchitis may be due to a squeeze or blow on the testicle, and I have known acute orchitis to follow a severe blow on the outside of the thigh, when the testicle has not been touched. Inflammation of the testicle may also be consequent on an attack of mumps, or may be due to constitutional causes, such as gout or rheumatism.

ACUTE ORCHITIS.—As cases of orchitis are not fatal, but few post-mortem examinations have been reported. Mr. Curling[1] examined two patients who died when suffering from acute secondary orchitis, and gives the following account of the changes that may be met with:—

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[1] Op. cit., p. 249.

> The tunica vaginalis is more or less distended with lymph or albuminous matter, which is infiltrated with reddish serum, and which forms loose adhesions between the opposed surfaces of the membrane; these adhesions are so slight as easily to admit of being broken down with the finger; the membrane is injected with a multitude of minute red vessels, which ramify in various directions and form a compact network. At a later period, red vessels may be traced proceeding from the free surface of the tunica vaginalis to the false membranes forming the adhesions; the volume of the testicle is very little, if at all, increased, the great bulk of the tumor being occasioned by the swollen epididymis and effusion into the serous sac. On section, the gland presents a darker appearance than natural, owing to the congested state of its bloodvessels. The epididymis, particularly its lower part, or tail, is enlarged to twice, and sometimes thrice, its natural size, and feels thick, firm, and indurated. This enlargement, which frequently forms the bulk of the swelling, is produced by the exudation of a brownish plastic substance in the connective tissue between the convolutions of the duct.

The specimen of orchitis which furnished the illustration (Plate XXXV., Fig. 10), was taken from a case of tetanus, and there is consequently no history of the local condition. It appears evident, however, from an examination of several microscopic sections taken from different parts of the organ, that the man had suffered at some former time from diffuse orchitis:—

> There is a narrow band running right across the testis antero-posteriorly, which is composed of fibrous tissue, and the seminiferous tubules lying in this band have become obliterated by fibrous tissue, which has grown in in loops from the *membrana propria* until the whole lumen is completely filled with fibrous growth. It is an interesting fact that this narrow band should exist in only one part of the organ, as it is difficult to understand how an inflammatory action could be confined to so small an area.

I am indebted to Dr. Coupland, physician to the Middlesex Hospital, for the following account of the post-mortem appearances presented by a case of acute orchitis:—

> A young man, aged 26, when suffering from orchitis (due to gonorrhœa), became delirious, at the height of the attack, and, leaping from a window, was impaled on some area railings. He was brought to the Middlesex Hospital dead, with two penetrating wounds of the abdomen, on February 27, 1877. A colored drawing was made, which represents the naked-eye characters of the testicles (the left only was inflamed), at the time of the post-mortem examination, about six hours after death. The left testicle was enlarged, swollen, and engorged; there was a little lymph in the tunica vaginalis; the body of the organ was mainly affected, and not the epididymis. The right testicle was normal. *Microscopic specimens* of the left testicle showed the tubules to be distended with cell products staining deeply with logwood. The intertubular tissue was also swollen by leucocytes and fibrinous exudation.

M. Terrillon[1] finds that in gonorrhœal epididymitis there is a purulent catarrh of the seminal ducts, and that, during the acute stage of epididymitis, the semen is of a greenish-yellow color, due to the presence of a variable quantity of pus-cells, which are associated with some granular cells. The spermatozoa may be absent from the commencement of the attack, or may persist throughout the course of the disease. In chronic cases the pus-elements are less abundant, the spermatozoa have disappeared in most cases, and in some do not reappear. In unilateral epididymitis the changes are similar, but less marked. In eight cases at the Hôpital du Midi, the seminal fluid resembled pus in color, and contained no spermatozoa.

MM. Terrillon and Monod[2] brought before the Société de Chirurgie an

[1] Annales de Dermatologie et de Syphiligraphie, Juin, 1880.

[2] Union Méd., 1881.

account of some interesting experiments, made by injecting an irritating fluid into the urethræ of dogs, which illustrated the pathological anatomy of blennorrhagic epididymitis. In man, observers have noted at the origin of the ejaculatory ducts redness and vascularization, and in the vas deferens redness and purulent fluid. The tunica vaginalis, which contains purulent fluid, is thickened, and the surrounding cellular tissue is inflamed. In dogs, four degrees of inflammation of the deferent canals are noted: (1) the mucous membrane is alone affected; the epithelial cells are altered, being swollen, granular, and in places wanting or deprived of their cilia. The vas deferens is not swollen, as there may be inflammation of its mucous membrane without swelling. (2) The mucous membrane is affected, and the wall œdematous and infiltrated with white blood-corpuscles. (3) Deferentitis, or as M. Terrillon prefers to call it "peri-déferentite," may exist, the periphery of the canal being infiltrated with serum mixed with white blood-corpuscles. (4) When the inflammation is intense, the liquid is greenish-yellow and contains many white blood-corpuscles and large granular fat-globules. The semen contains spermatozoa during the attack; the swelling of the *epididymis* is partial and affects the tail, which is of a greenish-yellow color. The canals of the epididymis are doubled and trebled in volume, and present cavities like abscess-cavities filled with pus. The epithelial cells lose their cilia and desquamate; the walls are red and infiltrated, and the inflammation extends to the cellular tissue. The swelling of the epididymis is more apparent than real, as it is in reality hardly doubled in volume; it contains spermatozoa; the surrounding cellular tissue is swollen, and the tunica vaginalis is inflamed. The testicle is a little indurated and increased in size, but is not inflamed to any extent.

M. Gosselin found a deposit of plastic matter in the cavity and in the walls of the convoluted duct. This matter consisted of fat-granules, granular globules of inflammation, and globules of pus; the connective tissue was free from deposit.

Inflammation of the testicle itself is rare, and may give rise to suppuration; when this occurs it is of consequence, as the pus is confined by the strong fibrous tunica albuginea, and will burrow among the seminal tubes and unravel them; and when evacuated by an incision into the tubes, may escape by the same opening and lead to the destruction of the gland. M. Deprès[1] contends that orchitis is due to retention of semen in the testicle from some obstruction to its escape by swelling of the mucous membrane of the ejaculatory ducts, of the vas deferens, or of the prostatic urethra. He says that seminal engorgements rarely lead to suppuration.

M. Verneuil[2] protests against the opinion so generally held that an orchitis can be produced by a strain. Velpeau and Gerdy both agreed that it could be so produced, as vascular congestion follows the compression of the cord by the abdominal muscles. Verneuil says that the testicle must already have been affected or predisposed.

A strong Covent Garden laborer applied at King's College Hospital, suffering from orchitis of the left testicle, which he attributed, and apparently with good reason, to the pressure of the abdominal muscles on the cord as it passed through them. He was in the habit of carrying very heavy loads on his left shoulder, and caused the orchitis, by "heaving them off," so to speak, that is by making a violent muscular exertion.

A student, when exercising on the parallel bars, was suddenly seized with acute orchitis, which was soon followed by effusion into the tunica vaginalis. He was positive that he had received no blow.

The testicle may be drawn up to, and compressed against, the ring by spasmodic contraction of the cremaster muscle (Tillaux). Beside inflammatory induration, stricture, and calculus, a common cause is latent tuberculosis of the testis, which is liable to be overlooked, as it does not present any well-marked symptoms; but the vesiculæ seminales and prostate, in some cases, may be swollen and tender.

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[1] Union Médicale, t. xxvi.

[2] Le Praticien, 24 Fév. 1879.

Orchitis follows in a certain number of cases after lithotomy, lithotrity, or other causes of prostatic irritation. Dr. A. Gordon[1] met with orchitis about once in fifty lithotomy cases. Mr. Hutchinson has noted its occurrence once in forty cases. The young are less liable to suffer than adults or the aged. In six cases the left testicle was attacked, in four the right, and in four cases the orchitis was double. The inflammation runs down the cord, and in five cases out of the fourteen, acute pain was followed by the formation of pus in the body of the testicle, requiring immediate evacuation.

In patients debilitated by disease or old age, acute orchitis may lead to gangrene of the testicle.

In one case of the interesting series collected by Dr. Hanot,[2] of orchitis occurring during an attack of typhoid fever, an abscess of the scrotum formed and discharged a reddish-gray material, which the microscope proved to be made up of seminal tubes. The testicle wasted to one-third of its original size.

Spontaneous gangrene of the testicle, occurring in a previously healthy patient, is rarely met with.

Professor Volkmann[3] has reported a case of acute hemorrhagic infarction of the testicle terminating in spontaneous gangrene. A boy aged fifteen, in good health, was seized with sudden, severe pain in the abdomen, attended with very acute constitutional disturbance, but the abdomen was lax and free from tenderness. The whole scrotum was very hard and œdematous, the left half being deeply congested, very hot, and tender. As it was thought that the tunica vaginalis had suppurated, an incision was made through the œdematous scrotum. The tunica vaginalis was of a dark-blue color, and contained a tablespoonful of dark blood. The surface of the testicle, which was five times its normal size, was smooth and glistening, and of a dark red color. The surface of the epididymis was also congested, and the plexus pampiniformis was filled with coagulated blood; the thrombosed veins were seen hanging down within the sac of the tunica vaginalis. The operation was done antiseptically, and the wound remained aseptic, but the testicle became necrosed and exfoliated. Microscopic examination showed that the hemorrhagic infarction had not been preceded by inflammation. No wandering processes and no accumulation of lymphoid elements could be seen—only vessels dilated and plugged by red blood corpuscles, with here and there evidences of extravasation of blood.

Sir Wm. Lawrence mentions an instance in which the testis and spermatic cord sloughed after an operation for strangulated inguinal hernia, although it was not known that the spermatic artery had been divided. He thinks that, owing to the alteration in the course of the cord, it might have been unconsciously divided by the operator.

I have given elsewhere the particulars of the case of a boy whose testicle sloughed after the operation for the radical cure of varicocele by antiseptic incision, ligature, and division of some of the veins. I have also referred to a case in which a testicle, retained in the inguinal canal, was acutely inflamed and became gangrenous.

Encysted Abscess of Testis.—Deposits of pus are at times encysted in the testicle, and occasionally give rise to sharp attacks of pain. Pyæmic deposits are very rarely met with in the testicle.[4]

Inflammatory Atrophy of Testis.—It is probable that the contraction of the material effused in orchitis constricts all the vessels and the tubes of the testicle, and causes them to atrophy. When enlarged, the epididymis is to be felt running behind and above the testicle; it is hard and irregular, the tail feeling like a marble; the vas deferens is swollen, and, together with the epididymis, is, in acute inflammation, very tender, but, when the inflammation subsides, the effusion into the tunica vaginalis which so often accompanies epididymitis, becomes absorbed, and the part may be freely handled. These cases should be most carefully treated because, owing to exudation into the cavity and walls of the ducts, obstruction to the passage of the semen may be caused.

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[1] Medical Times and Gazette, vol. ii. p. 126. 1871.
[2] Arch. Gén. de Méd., 7e sér., t. ii. 1878.
[3] Berliner klin. Wochenschrift, No. 53, 1877.
[4] Wilks and Moxon, Path. Lectures, 2d ed., page 533.

Acute inflammation followed a blow received on the right testicle when sliding down some banisters, and was treated at one of the London hospitals by rest in bed, aperients, and soothing applications; the patient left the hospital apparently well, but the testicle and epididymis began to waste, and finally disappeared, being ultimately represented by two small fibrous bodies, about the size of peas.

Special Varieties of Orchitis.—Sir James Paget[1] mentions a case of *gouty orchitis*, and states that it may be transferred by metastasis from one testicle to another. The following account of his own case was given to me by a married medical friend, aged about 50, who, when acting as "*locum tenens*," suffered from gout and gouty orchitis. He writes:—

I am a gouty subject, and was very well on August 15, when I caught a severe cold and cough, which, with constant out-door work and standing from 9 A. M. to 9 P. M., considerably reduced my health; then for three or four days my urine scalded when it was passed, and contained lithic acid; suddenly cystitis attacked me, with discharge of mucus and blood from the urethra, great straining, and supra-pubic pain. I had to go out driving one day, when I found my left testicle tender and swollen; it continued to increase in size until it became very large and heavy, with scrotal effusion; the urethral and vesical discharge ceased. I used belladonna ointment to ease the pain; it did so, but irritated the skin of the scrotum, causing a discharge, and its use had to be discontinued. The glands of the left groin and thigh began to swell, but gradually subsided. With rest and tonic medicine, assisted by very small doses of perchloride of mercury, the testicle was slowly reduced in size, but the scrotum still remained thick and occasionally painful. A swelling of the right knee came on, and subsided in six weeks, when the left testicle again became painful and slightly swelled about the globus major.

When examined by me, the left testicle was still swollen and slightly tender, and the epididymis was markedly enlarged. The sequence of the symptoms in this case is worthy of being noted.

Dr. V. Hanot[2] gives an account of four cases of orchitis which occurred spontaneously in some patients suffering from *typhoid fever.*

In all four the right testicle was attacked, presenting the usual symptoms of orchitis and being very tender on pressure. As a rule the epididymis and cord were free from inflammation and the tunica vaginalis from effusion. The orchitis came on when the patients, who were aged 21, 40, 32, and 18 respectively, were convalescing, but had not yet left their beds. In none did the urine contain pus, and there was no history of any injury having been received. In the fourth case, that of a man aged 18, an abscess formed and the seminal tubes were extruded. The tubes were separated by embryonic elements which, together with leucocytes, were also seen within the tubes. The epididymis could be felt *in situ.*

The association of *mumps* with orchitis is of interest and of consequence, as the inflammation of the testicle is at times followed by its atrophy. Mr. Curling says that he has met with two such cases. The orchitis appears about the sixth or eighth day after the onset of the parotid inflammation, just as the swelling is beginning to subside. It is not due to metastasis, but most probably to some blood infection, as the swelling of the parotid gland does not subside more rapidly on its appearance, and cases have been noticed in which orchitis has occurred *without* any inflammation of the parotid or *before* its appearance. On the fourth day of the orchitis, the testicle is two or three times its normal size, very hard, tender, and, as a rule, unaccompanied by hydrocele. Atrophy supervenes weeks or months after the attack. In some cases, fortunately, the atrophy is arrested, and the testicle recovers its normal size and plumpness; more often it persists; the other testicle may become hypertrophied. Atrophy of both testicles is followed by impotency; atrophy of one testicle by diminution of sexual power. Children are not attacked by orchitis when suffering from mumps, but an appreciable number of adults are, the onset of the complaint being occasionally ushered in by acute delirium. In a few instances meningitis has been met with as a complication.

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[1] Clinical Lectures, Brit. Med. Journ., May 22, 1875.

[2] Loc. cit., p. 595.

Professor Laveran, of the Val-de-Grâce Hospital,[1] in 432 cases of mumps observed among soldiers, noted 156 examples of single or double orchitis; one case of double orchitis occurred to five or six cases of single. Out of 111 cases, atrophy occurred in 73.

Mr. A. R. Manby's patient,[2] a man aged 19, a servant at a school where an attack of mumps was epidemic amongst the pupils, was seized with orchitis of the right testicle, which was ushered in by rigors and sickness. Twenty-four hours afterwards he had inflammation of both parotids. In one of Dr. Clement Duke's cases,[3] the orchitis appeared on the first day of the illness, the parotids not being affected from beginning to end, but only the submaxillary glands. Dr. Hall's patient, a boy aged 16, had reached the fifth day of the disease, and the parotitis had disappeared, when he was attacked with meningitis; this began to decline on the eighth day, when acute orchitis set in, which, however, subsided in a few days more.

M. Lereboullet showed before the Société des Hôpitaux[4] a soldier, aged 22, in whom a curious transformation had followed an attack of cynanche parotidæa. Four days after the appearance of mumps double orchitis came on, and the testicles swelled to the size of a fist; this passed away in three days, and soon afterwards the mumps also disappeared. In twenty days each testicle was atrophied to the size of a small almond, the epididymis remaining normal; sexual desire was lost; the mammary glands became enlarged; the hair on the face ceased to grow, the chin becoming smooth.

In syphilitic orchitis the atrophy is slow, and the microscope shows that the lesion has its seat in the reticular tissue which surrounds the seminiferous tubules; these then atrophy as the result of pressure. In the orchitis following mumps or masturbation, the atrophy goes on with rapidity, the epididymis often remaining intact. Under the microscope, the tubules, which are alone affected, present a notable hypertrophy of their internal coat, with atrophy of their epithelial lining, and disappearance of their lumen. The sclerosis is parenchymatous and not interstitial.

Rheumatic Orchitis.—In patients subject to rheumatic pains, Mr. Curling has noticed the sudden appearance and disappearance of inflammation of the testicle. Dr. Macleod noted in his work on Rheumatism, published as far back as 1842, cases of rheumatic inflammation attacking first one testicle and then the other. In 1861 M. Bouisson[5] reported some cases of the same kind. M. Reclus states that a man aged 61, who suffered from double rheumatic orchitis, lost both his testicles from atrophy. The pain in rheumatic orchitis is acute, attended with heat and tenderness, but no swelling, and, like rheumatic affections elsewhere, comes and goes suddenly.

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[1] Gaz. des Hôp., 1878.

[2] British Med. Journ., vol. ii. p. 584. 1877.

[3] Lancet, vol. ii. p. 744. 1881.

[4] Gaz. des Hôp., Août, 1877.

[5] Tribut à la Chirurgie, t. ii. Montpellier, 1861.

Variolous Orchitis.—Mr. Curling has failed, although he has made careful inquiries of the medical officers of the London Smallpox Hospital, to verify the statements of M. Gosselin[1] and M. Beraud,[2] that smallpox is associated with inflammation of the testicle. The latter observer describes two kinds, the *peripheral* variolous orchitis and the *parenchymatous;* the former is the more common.

It must be remembered that orchitis may be due to *malarial influences*, when it should be treated by the use of quinine and by removal to a healthy locality. Dr. Ellis and Dr. Duffey[3] have pointed out that orchitis may be a concomitant or sequel of Mediterranean fever.

Epididymitis may occur at any time during an attack of *gonorrhœa.*[4]

Diagnosis of Orchitis.—An attack of acute orchitis may present some of the symptoms met with in a case of strangulated inguinal hernia, the most prominent of which are nausea, vomiting, and costiveness, with swelling of the spermatic cord and pain extending to the loins. In cases of congenital hernia, the testicle will be obscured by the presence of the contents of the hernia in the tunica vaginalis, but in ordinary cases it can be seen and felt at the bottom of the scrotum. As a rule, a hernia has a history of some duration; it occupies the inguinal region, becomes distended on coughing, and disappears under pressure, or when the patient lies down; it first makes its appearance in the upper part of the scrotum, and forces its way downwards. When it has appeared but recently it will be small, but may be so tender as to make an examination difficult, requiring the use of an anæsthetic. The testicle is large, hard, and heavy, retains its form, and can be isolated from the cord above. If a retained testicle be inflamed, there will be an empty and undeveloped scrotum on the same side, and there may be a history of the improper application of a truss, of a blow, or of a gonorrhœa. The vomited matter consists of the contents of the stomach only, there is no distention of the abdomen, and the pain is referred to the side affected, and is not general. A purgative enema will bring away some fecal matter and clear up the diagnosis. As a rule, a hernial swelling is not as painful as an inflamed testicle, but the two conditions may be combined.

Prognosis.—The effusion into the tunica vaginalis, consequent on epididymitis, is soon absorbed, and the two layers of the membrane may become adherent. Hunter says that the hardness of the epididymis may continue for some time, even for life, but that seldom if ever do any bad consequences result from it, if the vas deferens be not rendered impervious; and not even then if it is only in one testicle, the other being equal to all the purposes of generation. The testicle sometimes wastes away after an attack of inflammation, and the ducts of the glands may become obstructed. In cases of double orchitis, the patient may be rendered sterile, owing to the passage of spermatozoa being stopped. The inflammation runs its course in about a week, and then subsides; the testicle remains tender for some time, especially after connection, and is liable to a fresh attack of inflammation. Varicocele predisposes to repeated attacks of orchitis; and gonorrhœal epididymitis, in its turn, aggravates the varicocele, and renders atrophy of the testicle more likely to occur. M. Gosselin has noticed a gonorrhœal inflammation of the *vas aberrans.* A hard cord ran in a straight direction from below upwards for a short distance on the outer aspect of the epididymis, and terminated in a hard, tender swelling. The testicle was unaffected.

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[1] French Translation of Curling on Testis, etc.

[2] Archives Gén. de Méd., 5e sér., t. xiii. p. 274.

[3] Lancet, 1881, vol. i. pp. 161–577.

[4] See Vol. II. p. 341, *supra.*

Treatment of Orchitis.—The patient is to be sent to bed, and the scrotum and testicles well supported by broad pieces of strapping, which stretch from thigh to thigh, and pass under the scrotum; or the same end may be effected by means of a crutch-pad placed between the thighs, well up to the perineum, under the scrotum; or by the support afforded by a horseshoe-shaped tray, made of gutta-percha or stiff cardboard, placed under the scrotum. In some instances the swelling will subside under the application of lead and evaporating lotions combined. If the inflammation be severe, relief will be undoubtedly afforded by the application of half a dozen leeches to the cord, or by section of several of the scrotal veins, after the patient has stood up and fomented the part; the bleeding is to be encouraged by fomentations. The inflammatory attack may be cut short at its commencement by the application of ice in India-rubber bags, or by means of iced water passing through a metal coil. In some cases, instead of giving immediate relief and cutting short the attack, the application of cold fails, and then it is advisable to apply sedative fomentations.

The *local applications* recommended for use in cases of orchitis are very numerous. Dr. Besnier, in addition to the usual treatment, keeps the part constantly enveloped in cloths saturated with a concentrated infusion of digitalis leaves, which may be used hot or cold, according to the feelings of the patient. A lotion of tincture of arnica (one part to six) may be applied, or a liniment composed of equal parts of tincture of arnica and soap liniment may be rubbed along the cord.

Lead and evaporating lotions give ease in some cases, and the constant application of sulphuric ether, as recommended by Dr. Assadorian, will be found valuable. Some surgeons paint the part with a tincture of iodine (ʒj to f℥j sp. vini rect.); others prefer to use a strong solution of nitrate of silver (gr. xx–xxx to f℥j). M. Bonnafont reports remarkable results from painting the part with collodion, but other observers do not speak by any means so highly of the remedy, as it causes smarting pain. An ointment of iodoform, one part to ten of vaseline, has been used. Belladonna ointment, or the extract of belladonna with glycerine, is a most useful application. Mercurial ointment, made with the oleate of mercury, or iodine ointment, will in indolent cases expedite the cure. Pressure by means of stimulating plasters, instead of by the ordinary strapping, is sometimes desirable. In some chronic cases the continuous galvanic current may be tried, as recommended by M. Terrillon.

For *internal use* we have in tartar emetic a powerful drug, and I have invariably found the following mixture efficacious when taken every four hours: R—Vini antimonialis, fʒss; Tinct. hyoscyami, fʒj; Magn. carb. gr. x; Magn. sulph. ʒj; Aq. menth. pip. f℥j. M. If there be much restlessness, Dover's powder and calomel may be given.

Seven-drop doses of tincture of arnica, with two-and-a-half-drop doses of Fleming's tincture of aconite, will be found of service when there is fever. Bromide of potassium and tincture of hyoscyamus in large doses, give relief in some cases; the latter ever since its strong recommendation by Mr. Gay, in 1844, has been constantly prescribed. Other sedatives when given in full doses, are very efficacious—such as morphine (gr. $\frac{1}{4}$ to $\frac{1}{2}$), lupulin, and camphor. Salicylate of sodium is the latest remedy proposed.

If suppuration be suspected owing to the symptoms of tension, as shown by a quick pulse, high temperature, shivering, swelling, and great tenderness, the part should be well fomented, and an early puncture made into the gland. In a case of epididymitis from gonorrhœa, injections and specific medicines should be stopped. When the acute symptoms have subsided, the testicles should be kept well supported in a handkerchief or a suspensory bandage, and strapping should be applied to procure the absorption of the products of inflammation. The patient is placed on a couch, the scrotum is shaved, and the swollen testicle, well separated from its fellow, is isolated in the lower part of the scrotum by a narrow strip of wash-leather strapping passed above it and encircling the cord; then narrow pieces of good strapping, about an inch broad, are passed from above downwards and before backwards, and pressure is made until the whole of the gland is comfortably encased by the strapping, which is finished off by another piece encircling the ends above; this must be renewed when it becomes loose, as it soon will do, owing to the subsidence of the swelling. It is important to procure an early absorption of the effusion in epididymitis, and for this purpose small doses of mercury are given: the mercurial ointment may be used so as to affect the gums slightly, or the liq. hydrarg. perchloridi may be given, combined with iodide of potassium and decoct. cinchonæ. Locally, absorption may be stimulated by the application of tincture of iodine, or of blistering fluid, lightly painted on. The cure will be expedited by change of air and generous diet. When the epididymitis is due to urethral stricture, this must be dilated.

Operative Treatment.—In cases of acute orchitis, with effusion of serum into the tunica vaginalis, the pain may be relieved by puncturing the membrane with a small knife, or by acupuncture. Vidal (de Cassis) recommended incision (*débridement*) of the *tunica albuginea*, in cases where the local or constitutional symptoms were severe. He declared that by division of the tunica albuginea the pain due to tension was relieved, and that the gland was in consequence less liable to injury. Mr. Curling is strongly opposed to this plan of treatment, but confesses that neither himself nor M. Gosselin, who approves his views on the subject, has practised the operation. M. Gosselin says that the cases in which puncture has been practised, or the great majority of them, have been cases of gonorrhœal orchitis, in which the body of the testicle very seldom suffers, and that the relief is due to the incision of the tunica vaginalis and the escape of the contained hydrocele fluid. He also doubts whether the tunica albuginea is opened at all, and says that he should expect an immediate hernia, or a secondary escape, of the seminal tubes to follow. In contrast to the large number (400) operated on by M. Vidal, M. Demarquay mentions four cases,[1] in three of which, after puncture for acute orchitis, the patient entirely lost his testicle by the escape of the seminal tubes; in the fourth the loss was partial. Salleron mentions that two soldiers lost their testicles in the same manner after like treatment.[2]

In 1876, Mr. Henry Smith, of King's College Hospital, advocated the treatment of acute orchitis, from gonorrhœa, by puncture of the body of the testicle. A narrow-bladed knife is passed into the most swollen part of the gland, and a puncture, the width of the knife-blade, is made in the tunica albuginea. Mr. Smith has had occasion to perform this operation many times, and I have myself followed his example in acute cases.

In the case of a friend who had struck his left thigh violently against a desk, the left testicle became acutely inflamed, and, as he would not then allow me to puncture it, I tried the usual sedative remedies; but these were so slow in their action, and he suffered so much pain, that he was afterwards glad to allow a puncture to be made. I passed a narrow-bladed knife through the coverings of the testicle into its substance; a quantity of serum spurted out from a small hydrocele; the relief was immediate.

I have, of late, contented myself by puncturing with a large suture needle, in five or six places. I have punctured the epididymis, when swollen, with good result. I am unaware of any bad consequences after the puncture as practised by Mr. Henry Smith; that it gives instant relief there is no question. The testicle does not, it is true, form the chief bulk of the swelling, but that it is not at all affected has not been demonstrated. MM. Demarquay and Salleron were certainly unfortunate in their experience. The objections urged against the proceeding seem based upon theory rather than experiment. That a testicle will waste after acute inflammation, however caused, is not questioned, and if a puncture will relieve the inflammation, its influence must be for good and not for evil.

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[1] Bulletin Général de Thérapeutique, t. lv. p. 549. 1858.
[2] Archives Générales de Médecine, Février, 1870.

Treatment by Compression.—Since Dr. Fricke, of Hamburg, first advocated the treatment of orchitis, whether acute or chronic, by compression by means of strapping, his method has become universal, since the relief of pain, and the diminution of the swelling by absorption, are undoubted. Some surgeons apply the strapping in acute cases; others wait until the acute symptoms have subsided. Care must be taken lest the strapping cause irritation or sloughing of the scrotum.

Very effective compression may be made by using Esmarch's or Martin's elastic bandage.

An instrument has been designed by Dr. O. N. White,[1] for securing safe and painless pressure on the testicle in cases of orchitis. It is made of hardened rubber, perforated with holes, as thin and as light as possible. The swollen testicle is placed within a shell-shaped shield, down the front of which a cleft runs which allows the two thin edges to overlap, and the pressure is regulated by means of a lace passed through small holes.

Professor Thiry,[2] of Brussels, has, for thirty years past, treated acute orchitis by methodical compression of the testicle. He applies a starched bandage combined with a spica of the groin, enveloping almost all the abdomen, and acting directly on the cord, which is swollen and tender, by means of graduated compresses. The patient is kept in bed, and given small doses of bromide of potassium and opium every three hours. In five or six days the dressing is changed for a suspensory bandage, and in a few days more the patient is well.

Acute inflammation of a *testicle retained in the groin* gives rise to a swelling like an inflamed inguinal gland, or a strangulated inguinal hernia; the scrotum on the affected side will be not only *empty*, but probably *undeveloped*. The treatment should be energetic, lest the peritoneum inflame, and should be carried out as already described. A puncture in a case of this kind would be advantageous, as it would give early relief, and if followed by wasting of the gland no harm would result.

CHRONIC ORCHITIS.—Acute orchitis is, as a rule, followed by resolution; the chronic form of the complaint is generally due to tertiary syphilis, and may be the only symptom of the disease present.

Chronic epididymitis may be the sequel of an acute inflammation, or it may be chronic from the commencement. The epididymis becomes increased in size, and hard to the touch. Obliteration of the canal is often present, and although it may occur at any part of the epididymis, is most common at the tail, where may be felt a hard fibrous nodule, which gives rise to a dilated condition of the canal. The swelling, unlike that caused by tuberculous deposits, is smooth, and not irregular and bossy. A hydrocele may be present, of a size sufficient to obscure the swollen epididymis. Reclus attaches much importance to the fact that the loop and sulcus formed by the vas deferens can be distinctly defined.

Chronic orchitis gives rise to but slight pain and swelling of the testicle, the surface of which is irregular. The seminal fluid is said to be slightly pinkish in color. This variety generally follows an acute attack, but orchitis may be chronic from the first. Reclus proposes to restrict the term chronic orchitis to a sclerosed condition of the testicle. This sclerosed condition, which tends towards atrophy, is rare after gonorrhœal epididymitis, but not uncommon after an injury. An interstitial proliferation takes place, which contracts and obliterates the seminal tubules. The testicle or testicles, for they are at times both affected, enlarge slowly, and without pain, and are often much enlarged before the patient seeks the surgeon's advice.

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[1] Boston Med. Journ., vol. cii. p. 99.

[2] Presse Méd. Belge, 5 Nov. 1876.

The term *atheroma testis* has been applied by Förster to cases of chronic inflammation of the testicle. The sac of the tunica vaginalis propria is obliterated by adhesions, and the tunica albuginea is much thickened. A large cyst with several small ones is formed, and is filled with a semifluid, atheromatous pulp, containing crystals of cholesterin, oil globules, granular cells, and yellow pigment. The wall of the cyst is covered with vascular granulations, and is at times incrusted with calcareous matter. The lining material resembles granulation-tissue, but when closed the cyst does not secrete pus, but granular cells, which may be seen in all stages of fatty degeneration. The process begins by causing a hyperplastic thickening of several main septa, which cause by their contraction portions of the testicular parenchyma to become strangulated, and to undergo fatty degeneration.

Chronic orchitis going on to suppuration was met with nine times by Billroth.[1] The disease usually occurred in healthy men, between the ages of twenty-one and sixty, and generally without known cause, though in one instance it followed a blow. Abscesses slowly formed in different parts of the parenchyma, and became filled with cheesy pus and lined with spongy granulations. The testis usually was completely destroyed, the general health being unaffected. In two cases the disease, which was unattended by pain, had existed for twelve and fifteen years respectively. Twice the abscesses were opened up and scraped, and then healed. All the patients were free from pulmonary phthisis, nor was there any history of gonorrhœa or syphilis. This form of chronic orchitis can only be diagnosed by the history of the case; sometimes even by anatomical examination it cannot be distinguished from tubercular or syphilitic orchitis.

Syphilitic Sarcocele, or Syphilitic Orchitis.—The best description of syphilitic orchitis, and the one generally adopted by writers, is that given by Virchow, in his work on the Pathology of Tumors. There are two forms of the complaint: the simple and the gummatous. In slight cases there is a chronic interstitial inflammation of the intertubular connective tissue, which is often associated with periorchitis (*albuginite syphilitique* of Ricord), and gives rise at times to a considerable, even cartilaginous, thickening of the tunica albuginea, associated with hydrocele. The cavity of the tunica vaginalis may become obliterated by complete adhesion of its walls. In interstitial orchitis, conical white bundles penetrate from the thickened tunica albuginea to the interior, and the intermediate tissue becomes dense and callous. These bundles are often lobulated, and are at times confined to one portion, but at others are spread throughout the testicle. This white compact tissue causes the disappearance of the seminal tubes, which it replaces, and, contracting after the manner of cicatricial tissue, causes a depression on the surface of the gland. When the complaint is more intense, yellow gummatous tumors are developed, sometimes in the thickened tunica albuginea, and at other times in the substance of the testicle itself. The yellow mass is seen clearly to result from the proliferation and subsequent fatty degeneration of the cells of the connective tissue. The new-formed connective tissue is the principal seat of the proliferation, which is not due, as Billroth says, to a croupous exudation around the spermatic canals. The increase in size and the nuclear division of the corpuscles of the connective tissue are well seen. At a later period the nodosities suffer fatty degeneration; a large collection of fat and granular corpuscles, at first large and then smaller, form in the centre, but, owing to the quantity of fibrous tissue present, the yellow masses are compact, dry, firm, and not soft like tubercular deposits. When the interstitial connective-tissue mass is young, soft, and vascular, it may easily be mistaken for tubercular or sarcomatous matter.

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[1] Clinical Surgery, New Syd. Soc., 1881.

Syphilitic orchitis, whether it cause simple induration, or a gumma, is an important complaint, as in bad cases it leads to a suspension of the secretion of spermatozoa on the affected side; but when the disease is partial, spermatozoa are still formed by the sound portion of the testicle. The yellow deposit is not vascular, the fluid used to inject the testicle stopping at the mass. At times, but very rarely, ulceration takes place, and gives rise to a benign fungus or hernia testis.

According to Rindfleisch, the syphilitic inflammation takes place in the connective tissue, and is followed by its fibrous condensation. The fibrous bands are conoidal in shape, with their bases at the thickened tunica albuginea, and their apices at the corpus Highmorianum. In the fibroid mass syphilitic gummata are formed; nodules, about the size of cherry-stones, being scattered throughout it. The corpuscular elements of the connective tissue proliferate, and then suffer fatty degeneration, but the intervening fibrous tissue persists, and gives the formation a tough consistency.

Microscopic Appearances.—On examining the testicle which furnished the microscopic specimen from which the accompanying drawing (Plate XXXV., Fig. 9) was made, it will be seen that it has become the seat of syphilitic infiltration, the whole gland being filled with fibrous tissue and with small round cells:—

In those parts which have been lately invaded, the fibrous tissue is disposed in narrow bands, with a large number of round cells on every side of them, and no part of the inguinal gland substance can be seen. This young tissue is well supplied with bloodvessels. In the older growth the bands of fibrous tissue have bcome larger, and the small cells much fewer in number, while the bloodvessels have become nearly occluded by a fibrous growth which appears to have grown inwards from their walls. In parts further advanced, there is nothing to be found but dense fibrous tissue with a few round cells, the vessels having entirely disappeared. It is a curious fact that the formation of fibrous tissue in its different stages is not confined to the testicle, exactly similar appearances being found in the brain; and it is impossible, on examining this new growth, to decide whether the specimen under the microscope is taken from the brain or the testis.

The *symptoms* of syphilitic sarcocele are unfortunately so slight that the patient either fails to notice the increase in size of the testicle, or neglects to report it to the surgeon; it is so at the commencement of the attack, and the relapses, which are far from uncommon, are neglected in the same way, much to the detriment of the organ. The symptoms come on gradually, with increase in the size of the testicle, which feels hard to the touch, and can be readily distinguished from the epididymis which is generally free from any deposit. If the disease progresses, the testicle becomes as large as a closed fist, oval in shape, and flattened from side to side.

The surface of the gland may be smooth, or bossy from the presence of hard nodules. When these are deep in the substance of the testicle, they escape detection, but when situated on its surface or on the tunica albuginea, they may be readily felt as hard, shot-like deposits, or the gland feels of unequal elasticity as here and there the tunica albuginea is thickened in patches. These appearances and the presence of a hydrocele are very characteristic of the disease. The skin of the scrotum is in no way altered.

The distinction between the epididymis and testis is eventually lost, the former being probably flattened out on the latter. Testicular sensation is diminished, and the patient allows the surgeon to handle the swelling roughly and to make firm pressure without complaining. The cord can be felt distinctly above: it is not enlarged, nor is it tender when squeezed; occasionally, however, an infiltration of the vas deferens will cause it to be uniformly enlarged. When the testicle is of a certain size the patient supports it, as its weight causes a dull aching pain which travels up the cord to the loins, and extends down the inner side of the thigh. In syphilitic sarcocele, both testicles may be unequally enlarged; if skilfully treated, as a rule the swelling subsides, but relapses are common.

M. Reclus met with one case of syphilitic sarcocele in thirty-seven adults suffering from syphilis, and it is said that it occurs in one-third of the infants suffering from constitutional syphilis. In most cases no reason for the onset of the disease can be assigned, but Ricord holds that a testicle which has been attacked by acute or chronic inflammation is more liable to suffer change than one which has not been inflamed or injured.

The enlargement of the testicle is accompanied as a rule by no constitutional disturbance, but other symptoms of constitutional syphilis may be present. When pus forms in the testicle it gives rise to local pain, and, being confined by the thick tunica albuginea, if not evacuated will cause disorganization of the gland. If the disease be allowed to run its course, the skin becomes adherent to the other coverings of the testis, inflamed, and purple, and, finally bursting, allows the seminal tubules to project and form a hernia testis.

Treatment.—Cases of syphilitic orchitis fortunately respond readily to specific treatment. If the orchitis occurs at a comparatively early stage of syphilis, and the patient has neglected to take mercury, this drug must be administered by the mouth or by inunction. In the more advanced cases, iodide of potassium is to be given in moderate or large doses, or a mixed treatment, employing protiodide of mercury pills, may be adopted.

Syphilitic Epididymitis.—The surgeon must bear in mind that, although syphilitic deposits are generally found in the substance of the testicle, yet they may be present in the epididymis.

A man, aged about forty, consulted me at King's College Hospital, for hard lumps connected with the left epididymis. On examination I found several small, hard deposits in the left, and also some smaller ones in the right epididymis, which had escaped his notice. He had had primary and secondary syphilis several years before. The situation of the swellings suggested that the deposits might be tuberculous, but the history of the case, the smallness of the hard nodules, and the healthy appearance of the patient, rendered it probable that they were due to tertiary syphilis; they became absorbed after a steady course of anti-syphilitic remedies.

I prefer the term "syphilitic epididymitis," applied to this condition by M. Dron,[1] to that of secondary epididymitis, chosen by M. Fournier. The deposits usher in the tertiary stage of syphilis, but have been met with in the secondary stage as early as three and a half months after the onset of the disease. Syphilitic epididymitis is most frequent in the earlier years of infection, and becomes rare after the disease has lasted four years. One or more small hard lumps as big as peas or hazelnuts, which are indolent and painless, and often escape notice for some time, are to be felt in the epididymis on one or both sides. In a case examined by M. Dron, spermatozoa were present.

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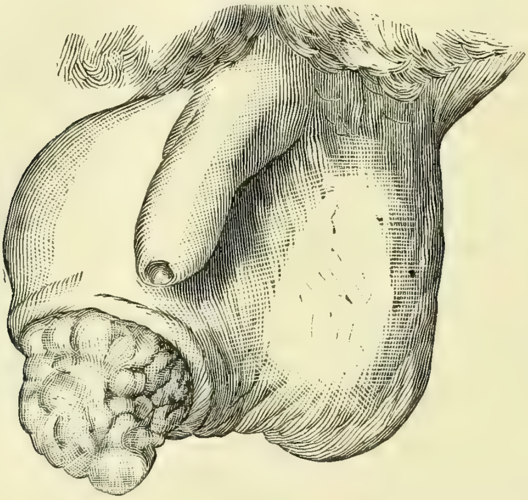
[1] Arch. Gén. de Méd., 6^{e} série, t. ii. 1863.

Benign Fungus of the Testicle.—The skin, tunica vaginalis, and tunica albuginea having become adherent through inflammation, ulceration may ensue, and be followed by a protrusion of the substance of the testicle. To this condition the name of hernia testis, benign fungus, or granular swelling, has been applied. In some cases the greater part of the testicle may be protruded. Examination by the microscope demonstrates the swelling to be composed of the tubules of the testicle, lymph, and granulation-material.

Fig. 1373.



Benign fungus testis; the granulating character of the protrusion is well seen.

After the escape of the tumor from its compressing envelope, tension is relieved, pain subsides, and the swelling becomes less, owing to absorption of the effused lymph. The base of the protrusion is surrounded by a thickened ring of indurated integument, this preventing the return of the swelling into the scrotum, which is often red and undermined.

On section, the tubuli seminiferi are seen as brown textures, disposed in straight lines radiating from the attached portion of the swelling to the circumference, where they are more or less apart. The other texture is white and granular, lying in the spaces which are afforded by the diverging rays, and is formed by organizable lymph, which is most abundant at the circumference of the protrusion. Mr. John Goodsir, on microscopic examination, found the protrusion to be composed of tubuli seminiferi and effused lymph, covered with healthy, exuberant granulations, and to be free from malignancy.

Sir William Lawrence[1] made a very important communication as to the pathology and treatment of this complaint as far back as 1808:—

> An examination of the fungus shows that it has its origin in the glandular substance of the testicle itself; that the coats of the part are destroyed to a certain extent; and

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[1] Edinburgh Medical and Surgical Journal.

that a protrusion of the tubuli seminiferi takes place through the aperture thus formed. The confinment of the inflamed and swollen substance by the dense and unyielding tunica albuginea, sufficiently explains the peculiar hardness and painfulness of the tumor. The absorption of the coats of the testis, and of the scrotum, obviates the tension of the parts, and thereby restores ease to the patient at the same time that the fungus makes its appearance externally.

As an improved method of treatment, Lawrence recommended removal of the fungus by means of escharotics, ligature, or the knife, instead of removal of the gland by castration, the previously recognized measure. With regard to this operation, Mr. Syme justly remarks that it requires a portion of the gland to be sacrificed in order to preserve the rest, and that in some cases the epididymis alone remains; moreover the treatment, whether conducted by escharotics or by the knife, is necessarily tedious. In the operation proposed by Mr. Syme, and which goes by his name, we possess a method of cure at once conservative, safe, and rapid.

Knowledge of the pathological changes which occur, induced Mr. Syme to argue that pressure was the most rational mode of treatment, and that this could be best applied by returning the tumor to its proper situation, in the scrotum, and by covering it with its natural covering, the elastic skin.

This is best done by making an elliptical incision around the base of the tumor, when, having removed the circle of indurated, undermined skin, and dissected up the integument in order to make a pouch for the reception of the fungus testis, this is to be placed in the pouch, and the skin is to be carefully united over it with wire sutures. The skin adheres to the surface of the fungus, and the cut margins unite together more or less by the first intention.

The above operation was a favorite one with the late Sir William Fergusson, who performed it in the manner described, but was in the habit of using harelip pins to keep the edges of the integument together, instead of interrupted sutures. I have seen a considerable number of these cases operated on by Sir William, and by Mr. Henry Smith, with remarkable success. Mr. Holmes Coote questioned the integrity of the testicle after hernia testis had been present. Mr. Syme differed in opinion from him, and Dr. Duncan's patient, having had his only testicle (the other having been lost previously) treated in this way, was satisfied as to its soundness and usefulness. This question, an important one from a medico-legal point of view, could only be settled by microscopic examination of the semen. Spermatozoa have been found in the discharge from the fungus before operation.[1]

Mr. Curling,[2] in 1843, advocated the treatment of fungus testis by means of a compress and strapping only. The same surgeon has practised the following operation, a modification of Mr. Syme's:—

It consists in making two or three radiating incisions, half an inch or more long, in the skin encircling the fungus, and dissecting back the triangular flaps of skin. The margin of the constricting ring is to be dissected off, and the fungus repressed by pressure. The sore closes by gradual cicatrization.

M. Jarjavay[3] describes a superficial form of fungus testis. Mr. Curling removed an enlarged testicle from a man aged twenty-four, which was associated with an open sore in the scrotum. There were several patches of yellow fibro-plastic matter in the body of the testis, and the whole of the epididymis was infiltrated and destroyed by the morbid growth. A considerable portion of fibro-plastic material grew from the visceral layer of the tunica vaginalis; injection entered the deposit, showing that it had become vascular.

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[1] Med. Times, July, 1850.

[2] Diseases of the Testicle (1st edition). London, 1843.

[3] Archives Gén. de Méd., 4me série, t. xx.

M. Reclus recognizes two kinds of benign fungus of the testicle, the non-parenchymatous and the parenchymatous. Wounds, inflammations, and gangrene of the scrotum are followed by the first variety, in which the tunica albuginea is entire, but exposed and covered with exuberant granulations; and but seldom by the second or parenchymatous fungus of the testicle.

Both kinds are met with in *syphilis*. A gumma forms in the coverings of the testicle, and at length bursts externally, when, through the aperture caused by the loss of substance, the testicle, covered by its tunica albuginea, projects as a hernia, and is covered with granulations forming a fungating mass, which shows no tendency to heal spontaneously. If the gumma be within the gland itself, a mass of caseous material is formed, which eventually opens on the surface; exuberant, fungating granulations result, and produce the parenchymatous variety of hernia testis. In *tuberculosis* the existence of the parenchymatous variety is not clearly demonstrated; on the contrary, the non-parenchymatous variety is indisputable, and M. Reclus explains its production as follows: A tuberculous abscess forms in the scrotum, one wall resting on the tunica albuginea, which becomes infiltrated with tubercles and covered with fungating granulations. The scrotum, thinned and disorganized, gives way; the testicle, already surrounded by a granulating membrane, escapes; and a hernia results. *Malignant* fungus of the testis, the *fungus hæmatodes* of the old writers, presents itself as a large, irregular, bleeding, soft, and stinking mass, which grows freely and invades the whole of the gland. This stage of the disease is marked by severe stabbing pains, cachexia, and enlargement of the spermatic cord and lumbar glands. *Benign* fungus protrudes through the testicular tunics, which are thickened and form a firm fibrous ring that constricts the swelling, this being of moderate size, firm, and covered with gray or red granulations, which discharge inodorous pus. A deposit forms in the testicle itself, and makes its way to the surface by suppuration and ulceration. The patient's general health is good, and there is no glandular infection. At the onset the patient suffers pain. A fungus following an ulceration of, or an abscess in, the scrotum, will be of the superficial variety. It is prudent, in cases of fungus testis,[1] to try the effect of a course of iodide of potassium on the swelling, before proceeding to operation. When the disease is allowed to run its course, the whole of the testicular substance is extruded, and the gland is destroyed.

TUBERCULOUS AND SCROFULOUS DISEASE OF TESTIS.

Orchitis occurring in strumous persons has been called *strumous or scrofulous orchitis*, *tuberculosis testis*, *tubercular sarcocele*, and *phthisis testis*. Most writers on the subject seek to discard the term "tuberculosis testis" as not being strictly accurate. Caseous inflammation is doubtless a serious condition, but not necessarily fatal, as general tuberculosis almost invariably is.

Dufour[2] looks upon tuberculosis of the testicle as a manifestation of a tuberculous condition of the constitution, and considers the caseous matters in the epididymis to be of a tuberculous nature, and not to result from a simple inflammation. Some pathologists, however, notably those of Virchow's school, no longer regard the caseous deposits of the epididymis as tuberculous. Rindfleisch[3] says that caseous deposits are found in the parenchyma of the gland, more or less globular in shape; they are commonly multiple; after a time they coalesce to form a single, irregularly nodulated, branching mass. The cheesy matter is peculiarly elastic until it softens down to form an abscess. The French school follows Laennec and Cruveilhier, who taught that tuberculosis might manifest itself by gray tubercle or by caseous inflammation.

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[1] Gazette Hebdomadaire, 12 Janvier, 1883, p. 17.

[2] Thèse Inaugurale, 1854.

[3] Op. cit., vol. ii.

Tuberculous deposits, unlike syphilitic, have a preference for the epididymis, are less often found in the substance of the gland, and, when present, are most abundant in the neighborhood of the rete testis, both glands being frequently involved. Syphilitic gummata are deposited in the substance of the testicle, the interstitial tissue between the seminal tubes being their seat. Caseous masses are found in the vas deferens, the epididymis, and the rete testis. The vas deferens, when attacked, is swollen and hard, the nodular masses affecting the duct, not throughout its whole length, but here and there, especially between the external abdominal ring and the testicle, and at its termination at the vesicula seminalis. When divided, a white creamy material may be squeezed out.

The epididymis, converted into a caseous mass, may be felt capping the testicle, but more often it feels like an irregular mass, presenting here and there large, hard, bossy swellings, which may be situated indifferently in its upper or lower extremity. The epididymis is surrounded, and its relations with neighboring parts are masked, by adventitious fibrous tissue. The crude masses, with their irregular margins surrounded by apparently normal tissue, commonly break down and discharge their softened material, giving rise to fistulæ; but occasionally they undergo a cretaceous change. Reclus finds that the thickened and dilated tubes of the epididymis, when affected by tubercle, may present on section well-defined, regular alveoli, some filled with purulent matter, but others empty. Gosselin applies the term "eccentric" to those tuberculous deposits which are intermixed with cretaceous material, and which are situated in the cellular tissue outside the vas deferens and epididymis, or in the vas aberrans. Chronic inflammation of the epididymis gives rise to yellow deposits unassociated with deposits of tubercle elsewhere.

Fournier has observed a rare condition of the epididymis, which he has called *pseudo-tubercular epididymitis.* It is apt to occur in the course of a chronic urethral discharge, without any apparent exciting cause. The epididymis may be at the onset subacutely inflamed, or a hard, irregular induration, slightly sensitive when squeezed, may be the first indication of the change noticed. The epididymis is swollen and hard, but is not invaded by large bossy swellings, as it is in tubercular disease; and Reclus attaches importance to the fact that the loop formed by the vas deferens can be traced. The previous history of the patient assists the surgeon in his diagnosis, and the deposit, unlike a syphilitic one, is but little affected by treatment. The prostate is normal, and the patient's general health is good.

Caseous deposits soften here and there, and give a sensation of fluctuation, the skin becoming adherent and livid in color; and, unless the matter be evacuated by the surgeon, they give rise to pain, and, finally bursting, cause fistulæ to form. Caseous tubercular masses differ from gummata in being whiter, softer, more friable, and, as a rule, more easily enucleated from the surrounding tissue than the syphilitic deposits, which are yellow, firmer, more extensive, and more firmly incorporated with the surrounding structures. The body of the gland may become ultimately affected through the extension of the disease along the rete testis, but it may escape altogether, the epididymis being alone involved. In general, tuberculosis attacking a young subject, very small, gray, transparent, hard tubercles are deposited in the testicle itself, in a soft, loose tissue which is found between the seminal tubes. These deposits coalesce and form larger masses of tubercle, which destroy the tubules, and, becoming granular, lose their distinctive characters. The tunica vaginalis is chronically inflamed, and may contain fluid, generally in small quantity, though sometimes the effusion is plentiful. The cavity is commonly partially obliterated by the presence of false membranes, and the obliteration in some instances may be complete. There may be serous collections in the small cells formed by fibrous bands stretching between the parietal and visceral layers of the tunica vaginalis. The bands and serous membrane are vascular, and some observers have noted tubercles scattered over them.

Reclus says that the effusion, which occurs in one-third of these cases, differs from that of ordinary hydrocele-fluid, being very dense, of a greenish-yellow color, and containing fibrous masses, some free, and others attached; it becomes solid on the addition of nitric acid. Other observers have not noted any difference. Broca has demonstrated the presence of greenish pus in the tunica vaginalis, which contained false membranes studded with tubercles. With the exception of fistulous openings, which are often multiple, and situated at the lower part of the swelling, the scrotal tissues are normal. Occasionally a depression is to be seen, and the fibrous tract of the sinus is to be felt, where a fistula has existed.

The affection is rare during infancy, becomes common at puberty, attaining its maximum between 15 and 35 years. The disease may remain latent until called into existence by a blow or some other irritating cause.

Reclus made thirty post-mortem examinations of men who had suffered from tuberculosis of the genital organs, and found that tuberculosis existed twenty times in the lungs as well as in the genitals, while ten times it existed in the genitals only. In thirty clinical observations he found deposits in the lungs in sixteen. Two per cent. of phthisical men were found to suffer from tuberculosis of the genital organs.

A certain number of patients suffering from caries of the spine present extensive strumous deposits in the epididymis. Reclus examined 34 cases, and found in 27 cases both the testicle and epididymis, and in 7 the epididymis alone affected.

Virchow has only met with one case in an adult, and one in a boy aged 3½ years, where tubercular ulceration of the testicle had occurred without an affection of the epididymis, so rare is it to find the disease attacking the testicle alone. Mr. Thomas Jones[1] showed at the Manchester Medical Society a tuberculous testicle removed from a child fifteen months old, who also suffered from disease of some of the cervical vertebræ. The body of the testicle was extensively invaded; the epididymis, on the contrary, was free from the disease; there was no nodulation; the cord and the scrotal veins were slightly enlarged.

The vasa deferentia, vesiculæ seminales, and prostate may be attacked simultaneously or separately. Leading pathologists who have paid special attention to this subject disagree as to the morbid changes presented in these cases. I have already stated Virchow's view, that small miliary tubercles form in the loose intertubular connective tissue, where they become confluent and caseous, and that they never originate in the epithelium, or in the interior of the tubules. They also form in the parietal connective tissue, especially in that of mucous membrane, as in the epididymis, in the vas deferens, and in the seminal vesicles. Nepveu holds that the miliary nodule springs from the adventitious coat of the bloodvessels. MM. Demme and Villemin consider tuberculosis to be an interstitial process.[2]

It has been contended that true tubercle always develops in the connective tissue, and therefore cannot do so at the expense of the epithelium of the spermatic ducts; but M. Thorn has demonstrated that tubercular granulations may arise in the alveoli of the lungs at the expense of the epithelium.

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[1] British Med. Journal, vol. i. p. 662. 1880.

[2] Mr. Hulke records an interesting case substantiating this view in the Medical Times and Gazette, vol. i., 1865.

Curling maintains "that the disease is originally developed within the tubes of the testicle; abnormal nutrition in the cellular contents of the tubes induces the formation of miliary tubercles in their walls. This view does not negative the development of tubercle in the intertubular tissue as seen by Virchow, or in the adventitia of the bloodvessels as observed by Nepveu."

Malassez concludes that the gray tubercle takes its start in the seminiferous tubule itself. An affected tube, when drawn out, carries with it the granulation-deposit, which is rounded or fusiform, and causes a symmetrical enlargement of the tube. The centre of the nodule corresponds to the lumen of the tube, and contains a finely granular substance, which is due to the proliferation and granular degeneration of the epithelium. The periphery of the nodule is constituted by embryonic elements, and, where the nodule is continuous with the wall of the seminal tube, the latter is thickened and rich in cells. Generally several tubes are drawn out together, being incorporated in the mass; to these he has applied the term "compound," and to the first that of "simple" granulation.

Cruveilhier has described a third type of the disease, the fibrous granulation, in which the size of the deposit varies from that of a millet-seed to that of a green pea. The connective tissue is in the ascendant: even the granular material of the centre is often absorbed, and only a transparent fibrous mass remains.

Neither Reclus nor Malassez is prepared to state positively whether in the testicle the proliferation commences in the intra-tubular epithelium, and makes its way from the centre towards the circumference, following the same course as in the epididymis and vas deferens, or whether it invades the layers of connective tissue from without inwards, finally affecting the epithelium. M. Malassez finds that the grouping of the cells, which are either round and granular, or of large size (migrated cells) and epithelioid in appearance, distinguishes the smallest gummata from tubercles, for in the former the cells are found in the interstitial tissue, apart from the seminal tubes and large vessels; whereas in the tubercular testis they are found about the canaliculi.

Dr. Justus Gaule[1] shows that tuberculosis of the testicle is often connected with tuberculosis of other organs, and that it begins in the epididymis as a catarrh of the seminal ducts and spreads thence to the testis. The walls of the ducts and the intertubular connective tissue become involved. The nodules or tubercles are formed of groups of seminal ducts plugged with the products of catarrhal inflammation, and tend to undergo caseous degeneration; giant-cell appearances are not uncommon, being formed by the epithelium lining the lumen of a duct, the wall of which is the seat of a small-celled reticulated growth histologically indistinguishable from tubercle. By caseation and softening, cavities are formed. Gaule suggests the name "phthisis testis," as both it and pulmonary phthisis commence by a catarrhal inflammation of tubular structures, which spreads deeper and involves the interstitial tissues; tubercular new formations may be superadded to the inflammatory appearances.

Billroth[2] has endeavored to substitute for the name "tubercular testis," the general term "circumscribed chronic (caseous) orchitis," as often there is no tubercular diathesis present, the patient appearing to be otherwise healthy. The formation of tuberculous nodules in the testicle is scarcely ever due to the coalescence of numerous small miliary nodules into one large mass; the limitation results from the strong septa, which partition off the gland into separate divisions. Billroth thinks that the irritating effusions are stored up here and there with the lymph in the lymphatics, which like the veins are convoluted, being often bent on themselves, forming loops, and that from them irritation spreads to the surrounding parts. It has not been proved that the nodules in the epididymis are composed of miliary tubercles.

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[1] Virchow's Archiv, 1877.

[2] Clinical Surgery.

In tuberculosis the change is, according to Rindfleisch, altogether interstitial, the tubuli seminiferi remaining quite passive. Rindfleisch and Kundrat are of opinion that the tubercle-cells arise chiefly from proliferation of epithelium, especially the epithelium of bloodvessels and their sheaths, and also of the lymphatic vessels and serous membranes. Rindfleisch also believes that the tubercle-cells may be developed out of the muscular cells of arteries; Ziegler has demonstrated that tubercles may also be formed by the confluence of migratory cells. The new formation is starved for want of bloodvessels; it dies in its centre, and only the cells at the periphery survive.

Buhl, after most careful investigation, finds that acute miliary tuberculosis is combined, in most cases, with the nests of caseous or suppurative inflammation of longer standing. He enunciates the bold doctrine that it is an infectious disease arising always from absorption of substances out of these nests, and the carriage of very minute particles into all the organs of the body.

Mr. Savory[1] is of opinion that, in the majority of cases, the so-called tuberculous disease of the testicle results from chronic orchitis, frequently of syphilitic origin, and that what is taken for crude tubercle is really cacoplastic lymph and inspissated pus.

Sir James Paget finds it difficult to say whether the yellow, dry, and cheesy material found in chronic enlargements and suppurations of lymphatic glands and of the testicles, should be regarded as tuberculous matter, or as withered and degenerate lymph or pus produced by inflammation. In testicular tuberculosis we should expect to find tuberculous matter in other parts of the genital apparatus, or in the lungs.[2]

It will be seen on looking at the drawing (Plate XXXIV., Fig. 1) which illustrates tuberculosis of the testis, and which has been faithfully copied from a microscopic specimen, that inflammatory action appears to have invaded the seminiferous tubule from a surrounding lymphatic space, and to have caused the seminal epithelium to become detached from the membrana propria and to coalesce in the lumen of the tube, where it undergoes a change and forms a gelatinous or colloid-looking mass containing a large number of nuclei, becoming the so-called giant cell. (Plate XXXIV., Fig. 2.) The whole of the following processes are well shown in succession in the single microscopic specimen that has furnished the illustration. (1) A normal seminal tube is seen. (2) One in which the epithelium is separated, and which, being seen in transverse section, appears as a ring. (3) This epithelium has become massed together in the lumen of the tube. (4) A giant cell is formed.

In the Anatomical Museum of King's College is the left testicle of a young gentleman who consulted me in the spring for a small swelling of the vas deferens, about an inch above the epididymis, and about the size of a small hazel-nut. It was soft and painless, situated in the course of the vas deferens, which was thickened, and felt like a small cyst. The patient, who appeared in perfect health, asked no questions as to the blocking of the canal by the deposit, and, thinking that in this case, at all events, ignorance was blissful, I did not give him my views on the subject. A month or two afterwards he said that he was better, as the swelling was smaller; he was no doubt correct, as I believe that the swelling, owing to the rupture of its sac, had become more diffused, and therefore softer and less evident to the touch, although in reality it was unaltered in size. I regret to say that I did not see the poor young fellow again alive, for he died in October under the care of one of my colleagues, of acute tubercular meningitis, after a very short illness. The little bag or cyst of condensed cellular tissue was connected by a narrower neck with the vas deferens, which was much thickened, and which contained a white, softish, caseous material. Its wall had given way at the point where the neck of the sac communicated with the interior of the tube, and had allowed the intra-tubular contents to escape. It is fair to ask whether the morbid material confined in the tube and cyst may not have given rise to the attack of acute tuberculosis, to which the young patient fell a victim.

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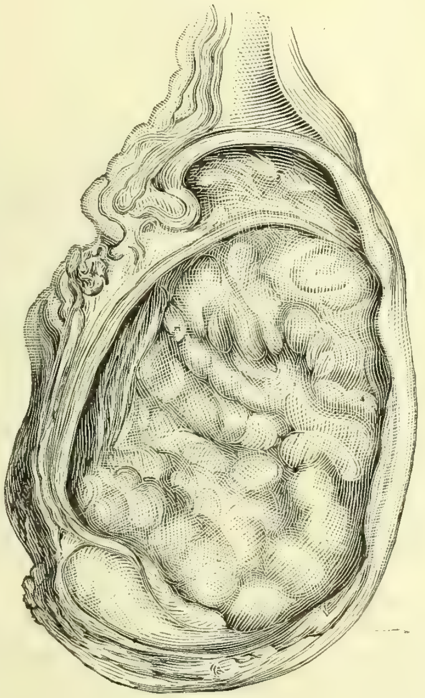
[1] Lancet, Jan. 1875.

[2] Lectures on Surgical Pathology, vol. ii. p. 602.

The tubercular deposits displace the tubuli seminiferi, which are discharged as shreds when softening and suppuration take place. The pus at times, owing to the absorption of the watery portion, becomes inspissated, and in some instances cretaceous masses are found. The abscesses discharge their contents through the ulcerated scrotum, through the perineum, or into the urethra. Granulations form at the circumference of the deposit. The discharge is very persistent, and gives rise to fistulæ. At times a benign fungus sprouts forth; at other times the gland wastes, and the parts contract and finally heal.

Fig. 1374.



Tubercular disease of the testis; the yellow strumous material is deposited with tolerable regularity throughout the organ.

Tubercular disease is most common in young adults, and generally commences by the formation of an indolent swelling of the globus major of the epididymis. The deposit gradually increases in size, and until the skin is affected is not painful. The testicle may feel uniformly enlarged. When the skin is adherent it becomes thin and purplish, and finally gives way, but a fungus testis does not often follow. When the case is associated with tubercle of the vesiculæ seminales, these may be felt as indurated swellings by the finger introduced into the rectum.

A thorough examination must be made of the lungs, and care taken to ascertain the presence or absence of syphilis. Prostatitis and cystitis are occasionally an early sign of tuberculosis; there is an obstinate gleet, which is painless, but attended at times by difficult micturition and spasm of the bladder. A sound will detect a tender spot, and at times the irritation may cause orchitis, or erections and nocturnal pollutions. In one-third of the cases there are small hydroceles. Palpation detects the changes in the epididymis, vesiculæ seminales, and prostate, but those in the testicle, though hard to discover, may be the first to occur.

Diagnosis.—Syphilitic sarcocele may be bilateral, and is constantly associated with hydrocele; but there are no lesions of the prostate. Hard knobs or cartilaginous plates may be felt in the tunica albuginea. Specific treatment is highly successful. *Malignant* disease of the testis is rapid in its progress, attains a large size, and after a time gives rise to pain, and to enlargement of the cord, scrotal veins, and lymphatic glands; it is unaffected by treatment.

The *prognosis* is serious: the morbid material may become encysted, but it is liable at any time to give rise to deposits in the bladder, kidneys, and lungs. Occasionally the peritoneum is affected. On the other hand, the deposits may remain localized, and though fistulæ may form, they may eventually heal up. The epididymis is completely obliterated; the discharge from the fistula very rarely contains spermatozoa.

That traumatic, functional, or infective irritation may give rise to the formation of nodules in the testicle or epididymis, Billroth has no doubt; and when he meets with indolent nodules in subjects otherwise healthy, he adopts no treatment, or uses iodine inunctions or compresses soaked in lotio plumbi. He has never seen these nodules disappear spontaneously, and considers them incurable. At the urgent request of a patient who had been told by his medical attendant that he was impotent, owing to the pressure of the nodules on the vasa deferentia, he dissected the masses out with antiseptic precautions. The wounds healed by the first intention, but whether the operation had the desired functional effect was not ascertained, as the patient was lost sight of.

Treatment.—These cases are to be treated by a generous diet, residence in a climate where the patient may live in the open air, and out-of-door occupation, when possible. Tonics, especially quinine, syrup of the iodide of iron, and cod-liver oil are useful. The genitals must be freely bathed with cold water night and morning. When the parts inflame, they must be rested and fomented, and when pus has formed it must be evacuated by a suitable incision. Unfortunately, instead of drying up, the abscesses continue to discharge thin, curdy pus, fistulæ remaining. Strumous abscesses of the testicle have been opened by caustics instead of by the knife, and injected with astringent and alcoholic injections, or with tincture of iodine or other antiseptics. The caustic paste of Canquoin or caustic potassa has been introduced into the centre of the abscess. M. Chassaignac advocates free drainage with his India-rubber tubes, and in 1851 M. Malgaigne proposed resection of the affected parts, which in some cases has proved advantageous. M. Verneuil[1] scrapes out tuberculous deposits from the testicle with the sharp spoon, and then applies the actual cautery, which is made cone-shaped. The application gives relief for a year or two, and delays the recurrence of the disease.

If the discharge and irritation cause much local annoyance, or appear to be undermining the patient's general health, or if the gland be deemed useless in consequence of its disorganization by abscesses and sinuses, it should be removed. A careful examination of the lungs should be made; also of the prostate and vesiculæ seminales, by means of the finger introduced into the rectum. The condition of the kidneys and bladder must also be noted. The removal of a source of irritation is likely to be attended by good results, and the possibility of general tuberculosis arising from a tubercular deposit in the testicle may furnish another reason for the removal of a damaged organ. Castration is, moreover, an operation fortunately unattended by much danger. Mention has been made elsewhere of the condition of the semen in these cases, and the absence of spermatozoa during the attack, and even in a very early stage of the complaint, has been noted. A careful examination of the semen of a middle-aged married man, whose sexual powers were failing, and who had an extensive deposit in each epididymis, failed to discover spermatozoa. He presented a well-marked angular curvature in the dorsal region of the spine, but was unaware of its existence, and was unable to give any account of it.

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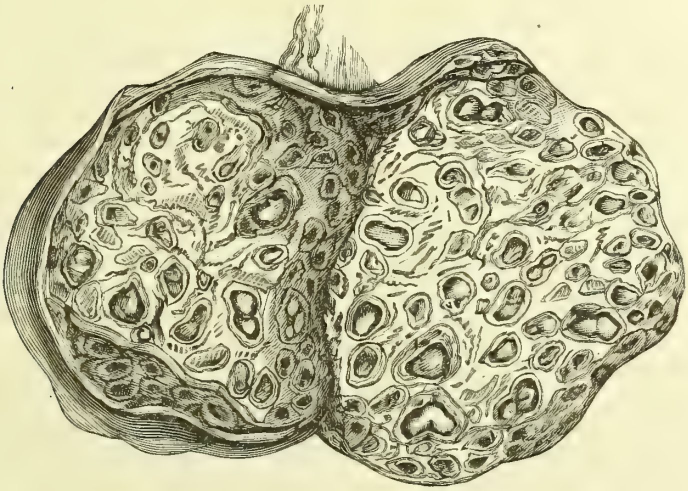
[1] Gaz. Méd. de Paris, Nov. 1871.

CYSTIC DISEASE OF THE TESTIS.

Cystic disease, cystoma, or the "hydatid disease of the testicle" of Sir A. Cooper, is rarely met with. The disease described by him was a purely local one, non-malignancy being the essential characteristic of the growth, which was formed of cysts and fibrous tissue only. Modern observers have, however, noticed that often it is associated with sarcomatous or carcinomatous structure, and is apt to run an unsatisfactory course. They have therefore recognized two kinds, the non-malignant and the malignant: in the former, which is more common than the latter, the cysts are lined with tesselated epithelium; in the latter they contain nucleated cells, and the patient is liable to a return of the disease after its removal, and to constitutional infection.

Fig. 1375.



Cystic sarcoma of testis.

A middle-aged man, in excellent health, notices by accident, after a blow or a squeeze, that one of his testicles is larger than it ought to be. The swelling is not painful, but increases slowly in size, being oval with flattened sides, and causes a dragging sensation. The veins of the scrotum and spermatic cord enlarge. The tumor is smooth on the surface, and softer in some parts than in others, where the cysts approach the surface and give a sense of fluctuation. Testicular sensation disappears as the disease advances. Sir A. Cooper inclined to the belief that the cysts were due to enlarged and obstructed seminiferous tubes, and proposed to call it the "tubular disease" of the testis. The greater part of the cavity of the tunica vaginalis, distended by the growth of the tumor, becomes obliterated by adhesions, while the unobliterated portion may contain hydrocele fluid. The tumor is composed almost exclusively of tough-walled cysts, joined into a compound, elastic mass by their opposed walls, and by a small quantity of intermediate, tough, and apparently fibrous tissue. They are for the most part oval in shape, and their size varies from that of a millet-seed to that of a pigeon's egg; they are not separable by dissection from the surrounding substance. In some cases the cysts are simple, with smooth walls lined by tesselated epithelium. In others they contain lobulated intra-cystic growths, of a cellular structure, covered by cylindrical epithelium, with or without cilia. The fluid in the cysts varies; in some it is clear, in others bloody and glairy; at times, instead of being mucous or serous, the contents may resemble the caseous material of dermoid cysts. Microscopic deposits of cartilage may be scattered throughout the growth, or transparent nodules, which may grow and fill up the cysts to a great extent, may be seen with the naked eye disseminated throughout the tumor. The cystic growth is separated by a capsule from the gland-tissue, which is spread out unchanged on the surface of the cysts; these may in some instances be removed by operation, and the secreting structure left. Professor Humphry recommends this proceeding, if by any chance only one testicle be present. The epididymis, free from disease, is attenuated and spread out, and finally the distinction between it and the tumor is lost. Beside sarcomatous or cartilaginous tissue, new formations of striped muscular fibres may be found.

Mr. Curling, who has investigated the subject with great care, states that the cysts are formed by a dilatation of the ducts of the *rete testis.* The dilatation may be at the end of a tube, or may spring from its side, or the tube may be uniformly dilated. No spermatozoa are found in the cysts. The cystic change is due to a morbid condition of the ducts, the *rete testis* being the part attacked, and not the tubuli seminiferi or the ducts of the epididymis. According to Rindfleisch,[1] an analogy exists between this disease and the "adenoid sarcoma" of the mammary gland described by Billroth. The proliferation is concentrated in the sub-epithelial connective tissue, that is, it presents the appearance of an enormous thickening and round-celled degeneration of the tunica propria. This is complicated on the one hand by dilatation of the ducts, on the other by phyllodic proliferation in their interior. Yellowish-brown globular concretions made up of horny epithelium, which are peculiar to the generative glands, are suspended in the fluid contents of the cysts. Klebs considers cystoma of the testis to be an advanced stage of adenoma, with proliferation of the seminal tubules, the tunica propria, and loose connective tissue. Förster describes the cysts as being due to an enlargement of the seminiferous canals, the epithelial lining of which becomes detached, and, filling the cavity of the cysts, suffers degeneration into a homogeneous and mucous liquid; at times the contents are caseous.

According to Trélat, a new product, composed of normal fibrous tissue and perforated by different-sized cavities, forms, gradually invading the testicle and displacing its substance towards the tunica albuginea. M. Nepveu has traced the process of enlargement of the seminiferous tubes, and has demonstrated the presence of pearly globules of horny epithelium. Many tumors of different histological structure have been included under the term cystic sarcoma, and M. Malassez has examined cysts which presented no likeness to the seminiferous tubes; whence he concludes that the epithelium is a new formation as well as the cysts, and he suggests the name of myxoid epithelioma. A diseased testicle removed by Sir Henry Thompson[2] was found to be a combination of cholesteatoma, enchondroma, and encephaloma, with cysts, within the dilated and thinned tunica albuginea. Some of the tubes between the cysts were unaltered, while others were dilated and filled with changed cells. After the patient's death, deposits of medullary cancer were found in the lymphatic glands, lungs, etc.

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[1] Op. cit., vol. ii. p. 196.

[2] Trans. Path. Soc. Lond., vol. iv. p. 180.

These cystic tumors, which attack one testicle only, are found at the middle period of life, and if not removed by operation will attain to a considerable size.

Mr. H. V. Carter has reported[1] the case of a child under three years of age, in one of whose testicles were a number of cysts, varying in size from that of a millet-seed to that of a horse-bean, containing a clear, glairy mucus, and lined with ciliated epithelium.

In cystic disease the swelling fluctuates here and there, where the cysts crop up to the surface, and hard cartilaginous nodules may sometimes be felt; the tumor is not transparent, and is heavier than a hydrocele, but not as heavy as an encephaloid tumor. A hæmatocele appears rapidly after a blow, and testicular sensation is generally evident. It is not possible, in some cases, to distinguish a cystic sarcoma from malignant disease, and as it is itself often associated with carcinoma and different forms of sarcoma, it is very necessary to give a cautious prognosis, even after a microscopic examination has been made. A cancerous mass, however, becomes painful, and increases in size by fits and starts, while its tension is unequal, being so slight in some places as to produce a false sense of fluctuation. When a cancer is punctured, blood freely flows, but the size of the tumor remains the same; whereas a cyst gives exit to a clear or viscid fluid, and collapses. A portion of the tumor may be scooped out prior to an operation, and examined by the microscope. If the cysts contain tesselated epithelium and no cancer-cells, the prognosis is favorable.

Early removal of the cystic organ is the only treatment to be recommended.

Dermoid Cysts in the Testicle and Scrotum.

Dermoid cysts containing skin, hair, bone, teeth, etc., have been found in the scrotum, associated generally with the right testicle. Professor Goodsir found in Dr. Duncan's case, skin, hair, and cartilage. Mr. Marshall removed from a young man, at University College Hospital, a testicle which was as large as an ostrich's egg, containing oily matter like melted butter, which solidified on cooling, and fœtal remains.[2]

Velpeau excised, from the scrotum of a young man, a congenital tumor which contained all the anatomical elements of a fœtus.[3] Velpeau held that the fœtal remains were first situated in the abdomen along with the testicle, and afterwards accompanied it into the scrotum. Verneuil,[4] who collected ten cases in 1855, found skin, cartilage, and the gray matter of the brain included in the tumor, and was of opinion that the inclusion was extra-testicular. In some instances the tumor is formed in connection with the testicle before its transition, and in others is first developed in the subcutaneous tissue of the scrotum, independently of the testicle with which it becomes connected subsequently. Paget considers that these highly organized and productive cysts are the result of great formative power in the fœtal or earliest extra-uterine periods of life. Klebs and Kocher, when well-marked parts of the body are found in dermoid cysts, adopt the theory of the inclusion of a second germ; but when only some tissue foreign to the testicle, such as skin, mucous membrane, muscle, etc., is present, they believe that an accidental grafting of the germs of such tissue has taken place in the rudimentary testicle, at the early period of development, when, according to Waldeyer, no distinction of germinal layers can be made in the region of the axis cord.[1] MM. Ollivier (d'Angers), Lebert, Littré, and Robin seek to draw a distinction between scrotal inclusion and dermoid cysts. Some theories admit a somewhat strained analogy between the ovary and the testicle, and suppose an isolated proliferating faculty. Others hold that the two glands are provided with a common element, the germinative epithelium. These theories cannot be substantiated, as it has been clearly demonstrated that the fœtal inclusion may be quite independent of the testicle itself.

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[1] Trans. Path. Soc. Lond., vol. vii.

[2] Erichsen, op. cit., 1st ed., p. 931.

[3] Gazette Méd. de Paris, 15 Fév. 1840; Clinique Chirurgicale, t iii. 1841.

[4] Archives Gén. de Méd , 5e série, tomes v. et vi. 1855.

Dr. J. Bœckel's[2] case was that of a man, aged 38, who had enjoyed good health until a painful swelling appeared in the part, which gradually grew to the size of a hen's egg. This was punctured, and some dark fluid evacuated; acute inflammation and rapid increase in the size of the swelling ensued. Fearing that the growth was a sarcoma, castration was performed. On dissection the testicle was found to be *quite healthy*, being pressed backwards and downwards against the tunica albuginea, which was slightly thickened. The tumor, which contained the débris usually found in dermoid cysts, was inclosed in a pouch constituted by the deep layers of the scrotum, and was formed of a soft fibrous material, through which numerous cysts were scattered.

M. Léon Labbé met with this remarkable case in 1858:—A boy, aged 14, presented himself with a congenital tumor of the right testicle, which was nodulated, hard in some places, and soft in others. The tumor, after castration, was found to be implanted in the epididymis and corpus Highmori, the gland-tissue itself being quite healthy and independent of it. The tumor was essentially made up of a series of isolated cysts, inclosing sebaceous material, mucus, hairs, cartilage, débris, cholesterin, and epidermic cells. Two cysts filled with mucus contained, besides mucous glands, unstriped muscular fibres, papillæ, and villi (*villosités*), which rendered it highly probable that these were two portions of the intestine. Two arytenoid cartilages could also be distinctly recognized. These cartilages, together with the two ends of intestine simulating cysts, could only emanate directly from the internal leaf of the blastoderm: a new fact in the history of monstrosities by inclusion.

The tumors are congenital, but may pass unnoticed until active growth calls the patient's attention to the part; the fact that they are congenital is an aid to diagnosis. Exploration of the tumor with an acupuncture needle here and there, where indurated masses can be felt, may reveal the presence of bones. Repeated attacks of inflammation cause the testicle to waste and fistulæ to form, which give exit to fœtal structures, or allow the bones to be detected by a probe.

A careful dissection should be made with antiseptic precautions, and the cyst separated from the testicle; or the tumor may be laid open, its contents evacuated, and as much of the investing cyst removed as may be thought expedient. Should the testis be atrophied, or intimately incorporated with the tumor, no attempt need be made to save it.

SOLID TUMORS OF THE TESTIS.

ENCHONDROMA OF THE TESTIS.—In some rare instances, enchondroma of the testis is deposited as a solitary hyaline nodule, the size of a walnut or a fowl's egg. In many cases the nodule of cartilage is associated with a fibrocystic or carcinomatous growth, and the tumor attains to a great size. In the Hunterian Museum (Specimen 2386) is a thin section of an almost wholly cartilaginous testicle. It resembles the section of a lobulated cartilaginous tumor, consisting of several small, round portions of firm, compact, transparent, opaline cartilage, which are united by thin partitions of fibro-cellular tissue. The cartilage is of the hyaline variety, and is encapsuled.[1] The nodules of cartilage are developed in the interstitial connective tissue, and by their pressure cause an invagination of the walls of the tubes, according to the observations of Billroth;[2] and according to Waldeyer they encroach on the cavities of the veins. In the same manner the lymphatic spaces, which are so numerous, may be invaded, or they may be the starting-point of the growth. Billroth has described a distinct layer of cells which separates the cartilaginous process from the wall of the containing canal. Sir James Paget[3] considers that the cartilaginous masses are formed in the cavity of the canals, and has carefully recorded a case which clearly showed that the cartilage-cells invaded the lymphatic system, and were carried into the circulation. Tortuous, cylindriform, and knotted pieces of cartilage, closely packed and imbedded in a tough connective tissue, had invaded the testicle, and were covered in places by a layer of seminal tubes. The deposit of cartilage extended along the spermatic cord in a beaded manner, and was conducted through an enlarged lymphatic gland to the inferior vena cava, into the cavity of which it projected. Both lungs were stuffed with cartilage, and weighed over eleven pounds. Paget infers that the deposit was at first local

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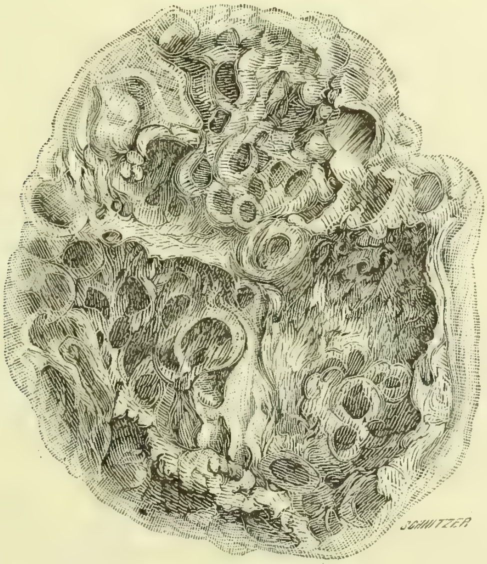
[1] Curling, op. cit., p. 408. London, 1878.

[2] De l'Inclusion péri-testiculaire, L'Union Méd., tome xxv.

Fig. 1376.



Section of an enchondromatous testicle: throughout the section are scattered rounded masses of cartilage; about half a dozen cysts are to be seen; the lower third of the tumor is made up of a sarcomatous mass, which contains a few nodules of cartilage and a few cysts.

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[1] Paget, Lectures on Surgical Pathology, vol. ii. p. 209.

[2] Virchow's Archiv, Bd. xiii.

[3] Medico-Chirurgical Trans., vol. xxxviii. p. 247.

in the lymphatics of the testis, and that by their instrumentality it became diffused throughout the body.

The tumor may grow to a large size, as a specimen removed by Mr. Henry Smith, which has furnished the accompanying illustration (Fig. 1376), demonstrates. It is made up of opaline, cartilaginous masses of various sizes, is associated with a sarcomatous growth, and contains a few scattered cysts. As a rule, the growth starts from the *rete testis* (Curling), and pushes the gland-substance on one side; but it may also invade the epididymis primarily or secondarily.

On section of a tumor of this kind, after it has been in spirit, the intercartilaginous tissue shrinks, the cartilaginous nodules, which are opalescent, projecting from the surface. In medullary carcinoma the cartilaginous nodules may be incorporated with the growth, or encapsuled. In cystic disease the nodules may be so numerous that they form the bulk of the tumor. The nodules may be round, about the size of a pea or a small hazel-nut, and continuous with the surrounding tissues, or they may be ovoid, elongated, and separated by areolar tissue. The cartilage-cells undergo fatty degeneration, and calcareous deposits may take place in the intercellular substance.

These tumors are by no means easy of diagnosis, and at times follow some injury to the testicle. The nodule when situated within the testicle is not readily felt. When the cartilage is associated with cancer, the internal deposits are cancerous, and not cartilaginous. The progress of these cases is slow, extending over four or five years, and not painful; they cause annoyance only by their weight and bulk. The tumor is heavy, and studded over its surface by small projections, some of which are hard, like cartilage, while others are elastic, owing to softening. The tumor is oval in shape, and devoid of testicular tenderness when pressed; if a hydrocele be present, it causes a sense of fluctuation; the spermatic cord is, as a rule, free from enlargement. Early castration is the only efficient treatment, and is of the first importance, as it relieves the patient of a testicle which is liable to injury, and of a tumor in which, although it may appear to be unassociated with sarcomatous tissue, yet a careful examination may discover not only sarcomatous but carcinomatous growths. Early removal is the more necessary if we concur in Professor Rindfleisch's opinion,[1] that the glandular and other organs of generation are generally far more prone than other parts to exhibit a transition of simple inflammatory irritations, of ulcers, of operation-wounds, and of catarrhal overgrowths (hyperplasiæ), into sarcomatous, and ultimately into cancerous degenerations.

Fibrous Tumors of the Testis.—When a testicle wastes after orchitis, all that remains of it is a small fibrous mass, about the size of a small marble, made up of the remains of inflammatory effusion, fibrous septa, and tubes of the testicle. A few cases are on record in which firm, wavy, fibrous tissue has been slowly developed, and has formed a tumor within the tunica albuginea. Sir James Paget narrates such a case in his lectures.[2] Förster[3] has also recorded a case in which a fibrous tumor was developed in the tunica albuginea, and invaded the substance of the testicle. Cruveilhier describes a case in his Atlas of Pathological Anatomy. Sir B. Brodie removed a testicle attacked by fibroma, and the remaining testicle was subsequently affected in the same way. These tumors are bulky and very hard, but are painless, and only cause inconvenience by their size.

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[1] Op. cit., vol. ii. p. 197.

[2] Lectures on Surgical Pathology, vol. ii. p. 118.

[3] Cornil et Ranvier, op. cit.

A tumor of the testis, which had been growing for eight years, was removed by Mr. Warrington Haward,[1] from an old man, aged 81. The right testicle, which was 5 inches by 3½, felt hard, nodulated, elastic, and heavy; some of the nodules, however, were less hard than others. There was some fluid in the tunica vaginalis. The cord was unaffected, and the skin was normal in appearance, and non-adherent. No secondary deposits were to be felt, and the patient's general health was good. The tumor grew from the tunica albuginea, the secreting structure of the testicle remaining normal; the growth creaked on section, and the cut surfaces became convex, and presented a grayish homogeneous basis with opaque white bands running through it. Under the microscope, wavy fibrous tissue was seen. The old man unfortunately died.

It would be well in cases of this kind, when the patient is old, to divide the spermatic artery, operating antiseptically, in the hope that the tumor might waste.

The specimen which has furnished the illustration of fibroid disease of the testicle (Plate XXXV., Fig. 5.), shows that the normal structure has disappeared. In its place there is found young fibrous tissue, and in parts this approaches myxomatous tissue, which is probably the earlier stage of this growth.

FIBRO-PLASTIC TUMORS, which are classified with the *sarcomata*, occur also in this gland, and are of grave significance.

A tumor within the tunica albuginea had, in seven years, grown to a measurement of nearly six inches by four. When first removed, it was to the eye exactly like a fatty tumor, but it contained no fat, and was a typical specimen of fibro-cellular tumor in a very œdematous or anasarcous state.[2]

CALCAREOUS MATTER, in some cases, is deposited in the epididymis, which is enlarged and hard; the seat of the deposit is most probably in some inflammatory effusion. It may also occupy the vas deferens and cause a blocking of the canal. The calcareous deposit may assume a laminated form, between the tunica vaginalis and the tunica albuginea, and is often seated in false membranes within the tunica vaginalis, in the same manner as in cases of pleurisy, but on a smaller scale.

In the Hunterian Museum are several specimens which illustrate the deposition of calcareous matter in the testicle and in the epididymis. That numbered 2429 consists of two portions of bone-like substance of light and delicately filamentous texture, composed of granules of earthy matter imbedded in seminal tissue, which were inclosed within a tumor connected with a testicle. Dr. Crisp had in his collection a ram's testicle, which was enlarged and converted into a mass of granular calcareous matter.

Cartilaginous deposits and fibro-cystic tumors may undergo calcareous change in their centres. The calcareous masses observed in the epididymis, rarely in the testicle itself, are often due to a cretaceous change in encysted tubercular deposits. When this calcareous change takes place, it causes a very hard swelling, and may give rise to an abscess, which is not likely to heal as long as the deposit remains to act as a foreign body.

The earthy material gives on analysis (Barry), phosphate of lime, 45; carbonate of lime, with traces of magnesia, 17; animal matter, 38=100.

CARCINOMA.—The scirrhous and encephaloid varieties of carcinoma are found in the testicle. The former is met with so rarely that its occurrence has been denied by Rindfleisch. The tumor attains a moderate size, and is chiefly characterized by its slow growth, stony hardness, and irregular, bossy surface; it does not usually protrude as a fungus. As a rule, the growth is accompanied by pain, which radiates from the testicle to the loins; the patient becomes cachectic, and is worn out by pain and gastric disturbance; painful œdematous swelling of the lower limb, and sometimes ascites, complicate the case. The tunica vaginalis becomes thickened from cancerous infiltration, and adherent to the gland. The tumor is very hard, creaks when cut, and shows fibrous bands, which radiate from the mediastinum throughout the organ. In the fibrous stroma are alveoli, which are filled with groups of cells, rounded or irregular in outline, and containing large oval nuclei. Small round cells are found in the intercellular tissue. The cells in places undergo a fatty or granular change.[1]

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[1] Trans. Path. Soc. Lond., vol. xxiii. p. 168.

[2] Paget, op. cit., vol. ii. p. 118.

The different names—such as medullary, brain-like, or encephaloid tumor, fungus hæmatodes (from its springing forth from its coverings as a soft, fungating, vascular, bleeding mass)—which have been applied to the growths which used to be considered carcinomata of the testicle, but many of which are now included among the sarcomata, give a good idea of the general appearance presented by medullary cancer or medullary sarcoma of the testis. The disease invades the body of the gland, which, owing to the tension caused by the tough, unyielding tunica albuginea, becomes very hard; eventually the morbid growth affects the whole of the organ, including the epididymis. Curling and Kocher consider the starting-point of medullary carcinoma to be the rete testis, whereas Robin places it in the tail of the epididymis. The epididymis and cord have been observed to be diseased, in cases of medullary sarcoma, when the testicle has escaped infection. The swelling is at first globular, with flattened sides, but subsequently causes thickening of the spermatic cord, and, when associated with a hydrocele, becomes more pyriform in shape. In some cases the lower part of the tunica vaginalis is obliterated, apparently from the pressure exercised by the large and heavy tumor. In some instances the surface is even; in others, smoothly nodular, owing to the irregular thinning of the tunica albuginea. At the onset there is no pain; as the glandular structure is displaced by the morbid growth, testicular sensation is lost. Blood-cysts, which are unlike those of cystic disease, being irregular instead of smooth and well defined, are caused by rough handling or by blows, when the tumor is soft. At first the patient is apparently in good health. The tumor grows to a large size in the course of a few months, and the veins of the scrotum become enlarged, and the cord much thickened. The testicle becomes so soft and elastic, and the skin so adherent and discolored, that the surgeon may be tempted to puncture the growth. The enlargement of the cord is associated with darting pains in the tumor, and up the cord to the lumbar region, where, if the patient be thin, the tender and enlarged glands may be felt by making firm pressure through the abdominal walls. The growth may burst through the tunica albuginea and become adherent to the scrotum, which finally gives way and allows the protrusion of a fungus hæmatodes, the foul discharge and bleeding from which exhaust the patient's strength.

The pressure of the enlarged lymphatic glands may cause a painful swelling and œdema of the legs. In the course of the complaint the patient suffers from dyspeptic symptoms, diarrhœa, nausea, vomiting, and distension of the abdomen; his rest at night is disturbed; he becomes cachectic and emaciated. The tumor on removal is oval in shape, and slightly uneven on its surface; on section it presents a number of fibrous septa, which inclose deposits of morbid tissue well supplied with blood. In some instances the gland-tissue is pushed on one side by the growth, but generally there is no gland-tissue left, as it is replaced by the new formation; this varies in firmness, being in some places hard, in others soft and brain-like, or shreddy; blood may be extravasated, and nodules of cartilage observed, here and there.

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[1] In the Hunterian Museum are two specimens. No. 2390 A is entered as a case of fibrous cancer of the testis in a child of four years (T. B. Curling, 1875); No. 4243 A, as a hard cancer of the testis (T. Macready, by A. A. Bowlby, 1883).

Retained testes seem prone to be attacked by carcinoma. The diagnosis is not at first easy, but as the disease progresses the nature of the case becomes more evident. The introduction of the antiseptic method of operating enables the surgeon to remove the growth by suitable incisions, with a fair prospect of success. The testicle is, as a rule, but loosely associated with the surrounding parts.

Dr. George Johnson[1] has reported a case of encephaloid cancer, affecting a testicle retained within the cavity of the abdomen. C. D., aged 27, was attacked, after a hard day's shooting, with pain which appeared to be near the bladder on the right side, but there was no irritability of that viscus; the pain was so severe that he was at times doubled up by it; the rectus abdominis was rigid. From being a muscular and athletic man, he became bent and haggard, and just above Poupart's ligament a swelling with dulness was detected. The urine was normal. The disease was fatal in less than a year. At the autopsy, a large mass, weighing sixteen pounds, was removed, and it is now preserved in the Anatomical Museum of King's College. The tumor was adherent to the abdominal walls, but was removed without difficulty. From the post-mortem description it appears that the mass might have been completely removed by abdominal section. The patient, a highly educated man, fretted so much over the absence of the testicle from the scrotum, that he told Dr. Johnson only of the circumstance, concealing it from his other medical attendants.

Sir Spencer Wells[2] removed a cancerous testicle which was retained within the abdomen. The operation, as far as the removal of the gland was concerned, was safely accomplished, but the patient unfortunately died in a week or two from pyæmia. Antiseptic precautions were taken, but thymol and not carbolic acid was used.

A man aged 53 was under the late Dr. Mahomed's care,[3] suffering from a hypogastric tumor which was semi-elastic, and which rose and fell with distension and evacuation of the bladder. Fragments of a highly cellular growth were removed through a canula. When first seen, there was no enlargement of the lymphatic glands, but this took place afterwards, and negatived any operative interference. After death, which occurred five months after the onset of symptoms, it was found that the right testicle was retained, and formed a mass of medullary carcinoma, free from cartilage, but containing colloid material. The body of the testicle, which still retained its characteristic shape, was turned upwards, its long axis being across the pelvis. The surrounding parts, and the cord, which formed the pedicle of the tumor, were not diseased; the testicle, which was completely non-adherent, could have been easily removed by operation during life.

The *differential diagnosis* of medullary cancer in its early stage is difficult, but is of great consequence, as an early operation is very desirable. In this disease the testicle enlarges quickly and continuously, without inflammatory symptoms. In King's College Museum is a specimen of hæmatocele, which was removed under the supposition that it was a malignant tumor. I have elsewhere pointed out the differential diagnosis between hydrocele and hæmatocele and a solid tumor of the testis. It most resembles cystic sarcoma and syphilitic disease, when the whole of one testis is uniformly enlarged; at an early stage it is not distinguishable from the latter, but its growth is more rapid and it soon outstrips it in size, since, instead of being as large as a fist, which is the extreme size attained by a syphilitic tumor, it may reach the size of a fœtal head, continuing to grow as long as the patient lives. After a time the vessels of the cord become dilated, and cancerous deposits are found in its tissues; the veins of the scrotum are also enlarged. A syphilitic history is a guide in some cases, and a double tumor will indicate a non-cancerous affection, as cancer does not attack both glands. The effect of specific treatment in the early stage is a valuable guide to diagnosis. In a case that came under my care, valuable time had been lost by submitting the patient to a mercurial course; his health was reduced, the testicle had become large, and the cord and lymphatic glands were affected to such an extent that an operation was deemed unadvisable. Cystic disease, when unassociated with cartilage—which can be felt as hard lumps in the tumor—may resemble carcinoma to the touch, giving a sense of fluctuation here and there, and being associated with a slight swelling of the vessels of the cord. Its diagnosis has already been considered. It is undesirable to puncture a medullary tumor of the testis, unless its removal, if necessary, be determined on, as a fungus is likely to sprout forth through the puncture. It is, however, always advisable to make an exploratory incision into the swelling at the time of operation, in order to ascertain its nature. Castration is alike the remedy for carcinoma and cystic sarcoma.

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[1] Medico-Chir. Trans., vol. xlii. 1859.

[2] Holmes's System of Surgery, 3d edit. vol. iii. p. 474.

[3] Trans. Path. Soc. Lond., vol. xxxiv. 1883.

Mr. Curling has collected the following cases of patients who survived for many years the operation of castration, done for soft cancer:—In two cases in his own practice, the patients were alive and well fifteen and five years after the operation; a patient under the care of Mr. Meade, of Bradford, was alive and well nine years; Mr. Cæsar Hawkins's patient twelve years; Sir James Paget's patient nine years; and Mr. Cock's patient six years after the operation.

A specimen of carcinoma testis under the microscope (Plate XXXV., Fig. 6) shows that all trace of normal structure has disappeared, and that a fibrous stroma with large cells of an epithelial type in its alveoli has taken its place.

Thiersch and Waldeyer hold that the cells of cancer are the direct descendants of pre-existing epithelial cells, and that true carcinoma can never arise where epithelium does not exist. The epithelium is that which covers free surfaces, and not that which lines bloodvessels and lymph-spaces or cavities, which is called "endothelium." Waldeyer considers that the alveoli of the cancer-stroma are merely lymph-spaces invaded by rapidly growing epithelium-cells.[1]

Birch-Hirschfeld has shown that in soft cancer of the testicle, the cancer-cells are lineally descended from the epithelial elements of the gland-tubuli; and that the isolated tubuli are studded with nodular, ill-defined protrusions, or else, expanding somewhat abruptly, pass continuously into the tumor itself. Rindfleisch maintains that the beginning of the growth consists of a proliferation of the epithelial elements of the testicle.[2] MM. Cornil and Ranvier do not consider the seminiferous tubes to be the starting-point of cancer, but believe that it is developed in the testicle, as in the connective tissue, by the swelling of the connective-tissue cells, and by the new formation of large cells which occupy the spaces of the connective tissue between the bundles of fibres and the lymphatic cavities.[3]

SARCOMA.—Of late years, tumors have been arranged according to their histological texture as disclosed by the microscope, and this method is more scientific and convenient than the old classification; but a medullary sarcoma not only resembles the medullary carcinoma, with which it used to be confounded, in its naked-eye appearances, but resembles it also in malignancy. The difficulty of diagnosis is still greater when, as not unfrequently occurs, different abnormal growths are associated in the same tumor. The trabeculæ of spindle-cells form spaces containing nests of true cancer-cells, which resemble transverse sections of seminiferous tubes lined with thin epithelium.[1] Mr. Butlin, in his critical lecture on the relations of sarcoma to carcinoma, delivered at the Royal College of Surgeons in June, 1880, accepts Waldeyer's theory of the epithelial origin of carcinoma, and defines this as a tumor of epithelial origin, having generally an alveolar structure, and sarcoma as a tumor of connective-tissue origin, formed generally of embryonic tissues, and without alveolar structure. The cells of carcinoma generally resemble those of the epithelium from which it grows, there is little inter-cellular substance, the vessels run in the fibrous tissue, and multiplication of cells is by endogenous formation; on the other hand, sarcoma is composed of round, fusiform, or giant cells, which are packed in a more or less abundant basis-substance, the vessels are mere fissures between the cells, and the cells increase in number by division. The most common forms of sarcoma met with in the testis are the round-celled and the spindle-celled, which originate in the tissue between the tubules. The sarcomata are associated with a great number of histoid growths in the testicle, such as cartilage, mucous and adipose tissue, and striped and unstriped muscular fibres.

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[1] Erichsen, Science and Art of Surgery, 7th edit., vol. i. p. 779.

[2] Op. cit., vol. ii.

[3] Op. cit.

It is not possible to distinguish without the microscope a carcinoma from a soft sarcoma; the former when cut yields a milky juice, the latter only after its removal. Professor Billroth[2] writes that the peculiar structure of the testicle causes most of the growths which originate in it to assume a lobulated, cancer-like, alveolar nature. The tissue of these new formations is usually soft. It is often impossible to say whether the growth originates from the delicate cellular tissue of the organ, from the endothelium of the lymph-spaces contained therein, or from the epithelial cells of the seminal ducts. I have much pleasure in quoting Mr. Butlin's analysis of his valuable table bearing upon carcinoma and sarcoma testis, which teaches many important points:—

The *round-celled* tumors occurred in persons aged between eight months and sixty-five years, but most often before the age of ten, or between fifty and sixty years. Both testes were not infrequently affected. None of these tumors contained cartilage, or any organized tissue other than fibrous. Glandular affection was absent in two post-mortem examinations out of six, and in these two cases the disease had existed for two months in one case, and five months in the second, and the lungs were the seat of secondary growths in one case only; yet in five cases there was widespread generalization in the bones and skin or subcutaneous tissue. And with the skin the liver was in one patient affected. Several of these round-celled tumors, especially in those cases in which *both testes* were affected and generalization was extensive, were examples of what has been called lympho-sarcoma or lymphadenoma of the testis, on account of the delicate reticulum which can be discerned amid the cells.

The subjects of *spindle-celled* sarcoma were from ten months to forty-five years old; but the disease was most frequent in patients under ten, or from thirty-five to forty-five. In no case were both testes affected. Cartilage was present in more than half of the cases. The total duration of the disease was rather longer in patients with spindle-celled than in those with round-celled sarcoma; several of the former lived three years; most of the latter only two. Affection of the glands occurred in every case in which the body was examined after death, and in two cases in which no examination could be made, a like affection was indicated by the presence of a large tumor in the pelvis and abdomen. The lungs contained secondary growths in every case but one, and in that case a large tumor occupied the situation of the kidney. In no instance was there extensive generalization similar to that occurring in the fatal cases of round-celled tumors.

With regard to *carcinoma*, there was only one patient under twenty years of age, a child of two years; the disease was most frequent between the ages of thirty and forty-five. The tumor never affected more than one testis, and was unmixed with other tissues. Affection of the glands was found in every case in which the abdomen was opened, and was strongly suspected in another patient. In two of the three complete necropsies the lungs and liver were the seat of secondary growths; and in the remaining case these organs were exempt, while the suprarenal capsule was diseased.

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[1] Rindfleisch, op. cit., vol. ii. p. 196.

[2] Clinical Surgery, p. 295.

The common occurrence of secondary deposits in the glands met with in cases of sarcoma is to be specially noted.

The longest total duration of the tumor was 42 months, and the shortest 7 months, in cases of carcinoma. In round-celled sarcoma the longest total duration of the tumor was forty-two months, and the shortest two months. In spindle-celled sarcoma the longest total duration was thirty-six months, the shortest seven months.

When the spermatic cord is enlarged, and the lumbar glands enlarged and tender, it is undesirable to operate; but if seen early, the tumor should be removed without delay, as the operation of castration is not a dangerous one, and the removal of the gland gives the patient for a season a gleam of hope, while death from internal disease, retarded for a short period, is less painful to the patient and less distressing to his friends than the death to which he would be liable at any time from a bleeding, offensive fungus hæmatodes.

LYMPHADENOMA TESTIS, the *lymphoid sarcoma* of Lücke, was first described by Malassez,[1] and afterwards by Monod and Terrillon.[2] The swelling is of a medium size, ovoid in shape, regular in outline, and of uniform consistence throughout, and it feels elastic when pressed. On section, the surface is homogeneous, without any appearance of softening, affords in scraping a little fluid, and presents the naked-eye appearances of an ordinary sarcoma. The epididymis escapes, but the growth has a tendency to invade both testicles simultaneously. Under the microscope it is seen to be composed of adenoid tissue; the cells are round, with a large nucleus furnished with multiple nucleoli, and a scanty protoplasm. The cells, which are small, are well defined, of formal outline, and of uniform size. The tumor is vascularized, not by the formation of vascular spaces or fissures between the cells, as in the sarcomata, but by capillary vessels with well-defined walls. When the cells are pencilled out, a fine reticulum, like that peculiar to adenoid tissue, remains. Generalization of the disease may occur at a distance in the cutaneous and subcutaneous tissues, the health remaining apparently good. The affection is a formidable one, and the growth should be removed as soon as its nature is recognized.

EPITHELIOMA, according to Nepveu, presents itself in the testicle under two aspects: (1) Pearl-like tumors—cholesteatomata (Müller), epithelial-perlen (Billroth)—which occur almost always in other tumors, such as carcinomata, sarcomata, etc., though one case is recorded where the pearls existed alone; (2) Epithelioma formed of pavement-epithelium cells, originating in the canaliculi and mixed with sarcomatous tissue.[3]

EXCISION OF THE TESTIS.

Excision of the testis is performed in the following manner: The patient, placed on a suitable bed, or on a firm, narrow table, should have the hair shaved from the pubes and scrotum. An anæsthetic having been given, and any rupture that may be present having been reduced, the surgeon stands on one side of the patient, and, having made the diseased testicle prominent, and having separated it from its fellow with the left hand, punctures it carefully to ascertain its nature; if he finds his diagnosis correct, he enters the point of his knife just below the external abdominal ring, and carries it downwards quite to the bottom of the scrotum, through all the coverings of the testicle; this wound enables him to turn the testicle out readily from its connective tissue, and provides for good drainage, and it is advantageous, as enabling the surgeon to verify his diagnosis, and to diminish the bulk of the tumor.

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[1] Bull. de la Société Anatomique, 1877.

[2] Arch. Gén. de Méd., 7e série, t. xii. 1880.

[3] Specimen 2451 A, of the Hunterian Museum, was presented by the late Mr. Partridge, and consists of a testicle and its epididymis, the latter being affected with epithelioma.

Some operators, however, prefer not to open the tunica vaginalis. If the testicle be torn out with the fingers, there will be less bleeding than when the knife is used, but the instrument will be required to divide the mesorchium, which attaches the testicle to the lowest part of the scrotum. The cord should be left to the last, in case total extirpation of the testicle should be deemed, for some reason, undesirable. It is to be prevented from slipping up into the abdomen by passing through it, above the point at which it is to be divided, a tenaculum, or a piece of stout string, which may be left for forty-eight hours. The cord may be cut through at once, and all the vessels carefully tied, especially the artery of the vas deferens (which may cease to bleed at the time of the operation); or the cord may be all divided except the vas deferens, which is severed after the vessels have been securely ligatured. I have seen Mr. Henry Smith, at King's College Hospital, effectually use the clamp and cautery to divide the cord, and have successfully followed his example. The old plan of tying the cord *en masse* has been rightly abandoned, as it was painful, and in some cases followed by tetanus. When adopted, however, the cord should be transfixed with a strong double ligature, and the two halves tightly tied, as the ligature is slow in separating. When the scrotum is adherent to the tumor, it is advisable to remove a portion. This is done by making two semilunar incisions over the growth, instead of a single straight one, and by removing the skin and the testis together. Some surgeons remove the skin even when it is healthy, in order to avoid the bag left after the removal of a large tumor, but this is unnecessary. The arteries of the cord and scrotum may be tied with thread or catgut, or twisted, as the surgeon may please. Chassaignac has employed the écraseur, to divide not only the cord but also its envelopes. Verneuil and others have secured the vessels with small leaden clamps. The edges of the wound are to be carefully brought together with silk or silver sutures, over a good-sized drainage-tube, which will expedite the cure. Before the introduction of anæsthetics the early division of the cord rendered the operation less painful and more expeditious, and it was recommended by Sir A. Cooper. Cases have been recorded in which retraction of the cord into the abdomen took place, after the removal of a heavy testicle which had dragged it down, and in which the surgeon was obliged to open up the inguinal canal in order to secure the vessels. The wound should be dressed with an absorbent dressing, and the parts carefully supported on a pillow. If the case be complicated by an inguinal hernia, this should be returned into the abdomen, the neck of the sac tied with stout catgut, and the boundaries of the inguinal canal brought together with silver wire or thick catgut.

Sir A. Cooper describes another method of amputating the testicle: An incision is made down upon the cord, just as it emerges from the external ring, but only large enough to permit the passage of a ligature between its bloodvessels and the vas deferens, so as to secure the cord from being retracted into the inguinal canal. An assistant then takes hold of the healthy testicle, including between his fingers not only the corresponding half of the scrotum but also the septum, while the operator with his left hand draws the diseased testicle in the opposite direction—so as to separate it as widely as he can from the other—and then with one stroke of a catlin removes both the gland and its scrotal coverings. The operation is rapidly accomplished—which was a recommendation before the introduction of anæsthetics—and the redundant skin is removed at the same time. It is applicable to cases where the tumor is not very large.

A retained testicle when diseased may be removed from the inguinal canal by making suitable incisions over it. The inguinal process of the peritoneum must be tightly ligatured with catgut.

It is very desirable to perform the operation of castration antiseptically. Recurrent hemorrhages are to be prevented by carefully tying the vessels, and, should bleeding occur, the wound must be opened up and the vessels secured; extravasation of blood takes place readily in the cellular tissue. In order to obtain good drainage, it has been proposed to make the incision at the back of the scrotum, but this is not necessary when a large drainage-tube is used.

Entozoa in the Testicle and Scrotum.

Entozoa are rarely found in the testicle. Sir A. Cooper describes an hydatid cyst which was situated in the epididymis of a testicle, removed from a dissecting-room subject, the gland being rather less than twice its normal size. In some few instances the *filaria medinensis*, or Guinea-worm, has been observed encapsuled in the scrotum. The presence of the *filaria sanguinis hominis*, in cases of elephantiasis scroti and other affections in the same neighborhood, has already been referred to.

Mr. Howard Marsh showed at the Pathological Society[1] the two spermatic cords of a man aged 46, with extensive hydatid disease within the abdomen. Each cord was occupied by an hydatid tumor of the size and shape of a hen's egg, placed just below the external inguinal ring; and, as these both contained fluid, they presented the appearance of hydroceles of the cord. On one side only the cavity lodging the hydatids communicated directly with the peritoneum, and was apparently the sac of an old hernial protrusion into the funicular process.

Functional Disorders of the Male Genital Organs.

Spermatorrhœa; Nocturnal and Diurnal Pollutions—We owe the term *spermatorrhœa* to Lallemand, who used it to designate morbid seminal losses; it is not well chosen, as continuous discharges from the urethra are found under the microscope to be destitute of spermatozoa. Galen erroneously considered that gonorrhœa, which is simply a purulent discharge, was due to a flow of semen. The semen as ejaculated is formed by the combined secretions of the testicles, vesiculæ seminales, prostate, Cowper's and other urethral glands. The testes produce a whitish, tenacious, inodorous mass, principally composed of spermatozoa; the fluid portion and the odor peculiar to the secretion are furnished by the union of the remaining secretions.

Dr. C. H. Ralfe[2] states that semen has the following composition: Water, 86 parts; solids, 14 parts (proteids, 6.5 parts; extractives, 1.5 parts; fats, 2.5 parts; salts, 3.5 parts).

The *albuminous* matters consist of ordinary albumen, which is deposited from an aqueous solution by a temperature of 73° C. (163.4° F.); an albumen precipitated from an aqueous solution by acetic acid, and which therefore resembles alkali-albumen, or casein; paraglobulin, which is deposited from its solution by magnesium-sulphate and by carbonic-acid gas; and myosin, which is thrown down from a dilute sodium-chloride solution by the addition of a dilute acid. Mucin is also obtained in small quantities by the addition of acetic acid to an alkaline solution. The peculiar albuminoid substance, spermatin, is probably a mixture of paraglobulin and lecithin.

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[1] Trans. Path. Soc. Lond., vol. xxv. p. 187.

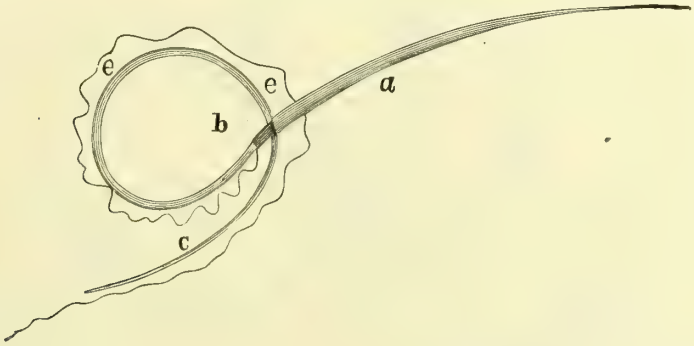
[2] Outlines of Physiological Chemistry.

The *extractives* from the aqueous and alcoholic extracts are, leucin, tyrosin, urea, kreatin, and inosite. Dr. Treskin has found a peculiar organic acid, the composition of which he does not give. The same observer has also found kreatinin, probably formed by the decomposition of kreatin.

The *fats* consist principally of a mixture of neutral fats, together with lecithin and cholesterin.

The *salts* consist principally of sodium and potassium chlorides, potassium sulphate, and especially of calcium and magnesium phosphate.

Fig. 1377.



Spermatozoon of the salamandra maculata. (*a*) a long-pointed head, (*b*) an elliptical structure, (*c*) a long filiform body, (*d*) a fine filament extending beyond the body, (*e*) a homogeneous membrane.

Dr. Heneage Gibbes, in his articles on the structure of the vertebrate spermatozoon,[1] states that a spermatozoon consists of a *long-pointed head* (*a*), at the base of which is (*b*) an *elliptical structure*, joining the head to (*c*) a long filiform *body;* a fine *filament* (*d*), much longer than the body, is connected with this latter by (*e*) a homogeneous *membrane.* The head, as it appears in a fresh specimen, has a different refractive power from that of the rest of the organism, and with a high power appears to be of a light green color; it presents also a central line, from which it appears to be hollow. The elliptical structure at the base of the head connects it with the long thread-like body, and the filament seems to spring from it. Whilst the spermatozoon is living, this filament is in constant motion, waving from side to side. The connecting membrane is only visible in fresh specimens, and disappears entirely on the application of glycerin. After placing the spermatozoon in a five-per-cent. solution of chromate of ammonium, the body and filament, as also the elliptical structure, can be stained with one color, while the head will take another. This is best shown by staining the spermatozoon first deeply with hæmatoxylin, when it will be found that the body, filament, and elliptical structure show the color well, but the head scarcely at all; on staining it then in a weak solution of aniline blue, if it be not left in this fluid too long, the head will be found a bright blue, while the body, filament, and elliptical structure remain colored with the hæmatoxylin. From his experiments and examinations, Dr. Gibbes concludes:—

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[1] Quarterly Journal of Microscopical Science, New series, vols. xix. and xx.

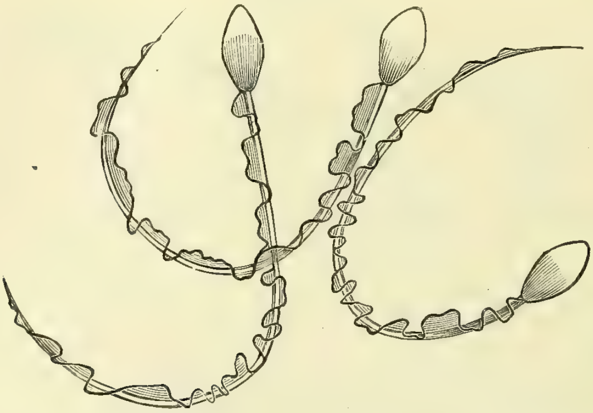
(1) That the head of the spermatozoon is inclosed in a sheath, which is a continuation of the membrane which surrounds the filament and connects it to the body, acting in fact the part of a mesentery.

(2) That the substance of the head is quite distinct in its chemical composition from the elliptical structure, the filament, and the long body, and that it is readily acted upon by alkalies (a solution of chloride of sodium, from $\frac{1}{2}$ to 5 per cent.). These reagents have no effect on the other part, excepting the membranous sheath.

(3) That this elliptical structure has its analogue in the mammalian spermatozoon; in the one case the head is drawn out as a long-pointed process, in the other it is of a globular form, and surrounds the elliptical structure.

(4) That the motive power lies, in a great measure, in the filament and the membrane attaching it to the body.

Fig. 1378.



Human spermatozoa. The filament is very fine, and is connected to the tail by a membrane which is much wider and longer than in the amphibia, and more folded in consequence. In one specimen, with no accompanying history, a number of heads were found with no corresponding tails.

When the spermatozoon is in motion, the head always advances through the spermatic fluid, and with sufficient force to turn on one side or push before it large epithelium-cells and urinary crystals if present. It is calculated that a spermatozoon in a suitable fluid can traverse in a second a distance equal to its own length, and it moves, according to Henle, at the rate of one inch in seven minutes and a half. The late Dr. Marion Sims estimated that spermatozoa travelled from the entrance of the vagina to the neck of the uterus in three hours. Hausmann has found live spermatozoa in the neck of the uterus a week after coitus, the alkaline secretions of the female genital organs being very favorable to the preservation of their vitality. Normally, the uterine secretion is alkaline, but if the mucus becomes acid the spermatozoa are killed, and the woman does not conceive—a condition which is sometimes removed by a visit to localities famous for their alkaline baths. A weak solution of mercury is very fatal to spermatozoa, but organic poisons do not affect them.

Spermatozoa live in the fluid of encysted hydrocele. M. Byasson preserved spermatozoa for 12 days, at a temperature of 36° C., in a fluid composed of phosphate of sodium, 59 grammes; the white of one egg; and water, 1000 grammes.[1] M. Roussin stains spermatozoa in a fluid composed of iodine, one part; iodide of potassium, four parts; water, one hundred parts. Longuet uses an ammoniacal carmine solution.

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[1] Bouchardat, Annuaire de Thérapeutique 1881.

The earliest age at which normal spermatozoa appear has not been definitely fixed, but Liégeois has found them in abundance in young subjects eight times: two 14, four 16, and two 18 years old. Wagner was the first to demonstrate normal spermatozoa in the semen of old men. Casper found them in a man 96 years old. M. Duplay examined the semen of 51 old men, and found spermatozoa present in 72.55 per cent., and absent in 27.45 per cent. M. Dieu examined 105 cases at the Hôtel des Invalides, and found spermatozoa present in 39 per cent., and absent in 61 per cent. In one-third of the above cases the spermatozoa were comparatively few in number, and not well formed as to size and caudal development. In a case of encysted hydrocele of the epididymis, recently tapped for a man aged 70, at King's College Hospital, the milky, slightly albuminous fluid, six ounces in quantity, was crowded with well-formed and lively spermatozoa.

Healthy men suffer from time to time during sleep from erotic dreams, which give rise to seminal emissions or pollutions; these are not only attended by dreams, but the individuals have erections, and awake at the time that emission takes place. These emissions are most common in young men with strong sexual feelings, which remain ungratified by sexual intercourse; as age advances, the testicles do not secrete so readily, and emissions happen but seldom. They occur more frequently to some than to others, and depend on the man's constitution, his occupation, mode of thought, diet, and the climate in which he lives. As a rule, an emission of this kind is followed by a sense of relief, and the health is not affected by it; the secretion of the testicles accumulates, and by its presence causes a feeling of uneasiness in the day time, and during sleep stimulates the vesiculæ seminales to contract. These seminal emissions, as long as they are not too frequent, are physiological and not morbid, and there is no hard and fast line separating the former from the latter state. The mere enumeration of the emissions does not suffice to determine whether they are morbid or not, as the health is affected sooner in some men than it is in others. They may take place every night, or even oftener, and may be attended by imperfect erection, and no sensation of emission. As they increase in frequency, the amount of semen lost each time is diminished. The patient is disinclined to exert his mind or his body, and complains of pain in the back and palpitation of the heart, which are associated with dyspepsia; his memory becomes enfeebled, and, owing to nervousness, his speech becomes thick, and he is at a loss for words to express his thoughts. After nocturnal emissions have persisted for some time, pollutions occur involuntarily in the day time. Healthy men do not pass semen involuntarily when awake; even when exposed to great sexual excitement, only a slight moisture, due to the escape of a drop of natural mucus, is perceived when the erection subsides. When a patient complains that nocturnal emissions take place too frequently, it is wise to take measures to lessen their occurrence, as when they are oft repeated the parts become irritable, and freely secrete and as freely discharge the seminal secretion. The case becomes serious when emissions occur not only frequently during sleep, but also when the patient is awake, and when they take place involuntarily and without the usual voluptuous sensations.

In cases suffering from diurnal pollutions, female society, friction of the trousers, a ride on horseback, or the motion of a railway carriage, will induce an emission, as will also appeals to the imagination by obscene books or pictures; these last may be called psychical causes, affecting the brain, in contradistinction to others which have to do with reflex action.

Lallemand's definition of spermatorrhœa took a wide range, for he considered "every profuse seminal discharge, in whatever manner it occurred," to be due to this complaint. Sir James Paget takes a very different view, for he writes that "if anything can be called spermatorrhœa, it is the condition of those individuals whose nervous systems are over-sensitive, or in whom the portion of the spinal cord which is in relation with the sexual organs is too irritable, ejaculation too rapid, and produced, without erection and sensation, even by the friction of the clothes, or when the imagination is a prey to lascivious thoughts." Trousseau, in a clinical lecture on seminal losses, drew attention to the association of these cases with nervous diseases, and especially with incontinence of urine in early life. He considered that spermatorrhœa existed "when losses or evacuations of the seminal fluid took place without any erotic excitement, or after a stimulus which would be insufficient to excite emission in a person in health." In these cases there may be some lesion of the genito-urinary tract, but the nervous disorders are always present, and are eventually followed by disorders of the general system.

Etiology.—The causation of the condition known as spermatorrhœa is obscure, and we must bear in mind that abnormal seminal losses are to be considered not as a disease, but rather as a symptom of disease. The conditions which produce malnutrition of the nervous system and of the body generally, produce also disorders of the genital organs. Besides the condition of the general health, local changes will, on examination, be discovered. Any debilitating illness, exposure to malaria, insufficient food, or want of exercise, may, by impairing the nutrition of the body, give rise to anæmia, and favor the production of seminal emissions. The clinical histories of these cases point to the conclusion that hereditary influences are at work, and that the patients have a predisposition to epilepsy and insanity, and, when children, have suffered from nocturnal enuresis (Trousseau). A potent cause of the complaint is found in sexual excesses of all kinds, and robust men may suffer because they have abused their sexual powers by excessive sexual intercourse, or more commonly by the practice of masturbation, commenced in boyhood and continued in after-life. Although in masturbation the amount of semen lost is less than in sexual intercourse, yet the nervous shock attending the emission is greater. The practice is often commenced at a very early age, and the opportunities to indulge in the act are many. Any irritation, such as a long foreskin, will produce a constant state of erection in infants. Children three or four years old have been known to masturbate. Any nervous disorder to which the child may have a tendency is under such circumstances developed; epilepsy and affections of the eyesight may result. The longer the habit has been indulged in, the more difficult is its discontinuance. Men differ widely as to their sexual power, and what is moderate indulgence—or, at any rate, harmless—in one, proves harmful to another. Trousseau was the first to insist upon the important part taken by the nervous system in the production of seminal weakness; before his time the symptoms were thought to be due to the loss of semen, which loss, however, is not excessive. Masturbation is the most common cause of spermatorrhœa. Sir James Paget narrates the following instructive case:—

> A man, aged thirty, suffering from spinal irritation, lay helpless and willless, weak-eyed and utterly enfeebled, a very type of the supposed victims of spermatorrhœa. Nocturnal emissions occurred very rarely; they were followed by increase of backache and other miseries, but in no greater degree than was every unusual mental or bodily effort. This patient had never had sexual intercourse, had masturbated only twice or three times in his life, and had had very few nocturnal emissions.

In some of these cases, he adds, rapid and frequent emissions are the consequence, and not the cause, of nervous disorder. Direction of the mind to the sexual organs makes them and the parts of the nervous system associated with them more and more irritable; it increases the secretion of the seminal fluid, and hurries its discharge.

Masturbation and sexual excesses act on the genital organs primarily, and secondarily on the general health of the patient, the parts becoming irritable and diseased owing to repeated excitations. The presence of semen in the receptacles in which it is stored causes reflex irritation, which gives rise to erection and ejaculation. The antagonism which naturally exists between the propulsive and retentive muscles is weakened; the former are more easily excited by central and peripheric stimuli, and the relaxation and enlargement of the ejaculatory ducts also favors an easy flow of semen. Ejaculations, instead of giving relief, act as stimulants to the genital organs, causing renewed secretion. Inflammation of the urinary passage, whether due to gonorrhœa or any other irritation, causes erections and emissions, especially in those who have a tendency to seminal discharges. Excessive coitus and masturbation are at times followed by urethritis and inflammation of the prostate, the testicle, and ejaculatory ducts; but on inquiry I find that at lunatic asylums, where cases of masturbation unfortunately abound, strictures and orchitis do not occur more frequently than they do without the asylum walls. The quantity of semen lost at the time of emission is slightly lessened in quantity and coagulability, the odor is fainter, and the spermatozoa are fewer in number than in the normal state.

The act of sexual intercourse is attended by great excitement of the nervous system, which commences with the erection of the penis, culminates just prior to the ejaculation of the semen, and ceases on the occurrence of this reflex action. The nervous excitement is followed by reaction, which, however, in a strong and healthy man, soon passes off, but in those who are sexually weak, leaves a feebleness and irritability behind, which give rise to troubles of function. So great is the nervous shock that the term *epilepsia brevis* has been used as synonymous with the sexual orgasm. It is said that too much stress has been laid by some on the nervous shock to the system, and it is asked how it is that the health of a certain class of women does not break down under the stimulus of excessive sexual intercourse. The reason is that the sexual act in the majority of women is not so intense, nor of such long duration, as it is in men, and that those who indulge in sexual intercourse with many men, restrain their feelings, and give way to sexual pleasure only with the few who find favor in their sight. It is probable, moreover, that many obscure cases of nervous disorder in the female are due to ungratified or abnormally gratified sexual feelings. Surgeons are not infrequently called upon to remove from the urinary bladder foreign bodies, such as hairpins and the like, which have been introduced for the purpose of exciting sexual feelings, the patient being incited thereto by some irritation of the part, which gives rise to sexual thoughts and a desire for sexual gratification.

Eckhard, by his dissections and experiments, has made the important discovery that certain spinal nerves govern erection; and Goltz has placed the primary centre in the lumbar region of the cord; the movements of the seminal ducts and vesicles seem also to be connected with the same part. The secretion of semen is arrested by injury of the spinal cord (Longet). Eckhard produced erections in rabbits by electrical stimulation of the pons, and of the points where the crura cerebri entered the cerebrum, while similar irritation of the cerebellum had no such effect. He concludes from this experiment that the "nervi erigentes" have their origin in the cerebrum, and that the cerebellum does not govern the sexual organs, as Gall used to teach. The cerebellum is not developed in proportion to the sexual propensities of the animal, nor does it waste after castration. Injury or disease of that organ very rarely produces any effect on the penis; but lesion of the medulla oblongata, or of the spinal cord, is very apt to occasion a semi-erection.[1] Frequent excitement of the peripheral ends of the nervi erigentes leads to an irritable condition of the centres which govern erection, so that emissions follow slight irritation, or even lascivious thoughts emanating from the brain. Sir James Paget, in his Clinical Lectures on Sexual Hypochondriasis, draws attention to the powerful influence of the nervous system over the sexual organs, and declares that it is as difficult to cure the want of co-ordination of the muscles in the one case as in the other, and that the condition is much affected by the state of the general health of the person. Erections, and a desire for sexual intercourse, after having been long in abeyance, are developed in and are an early symptom of locomotor ataxy. As well as a centre for the reflex phenomena, the brain is the seat of the imagination, which influences the functions of the male genital organs in a remarkable manner, and is excited by obscene books or pictures. There are men whose whole thoughts are devoted, not to useful mental work, or to out-of-door amusement, but to a consideration of the condition of their genital organs. Their minds are not sane, and they indulge in sexual excesses of all kinds; the mind acts upon the body, and excites an irritable condition of the genital organs; or the latter may be rendered weak by masturbation or sexual excess, and in turn wreck the mind.

The statement that animals masturbate, and that stallions when exposed to ungratified sexual excitement, suffer from spermatorrhœa, is questioned by some.

A congested or inflamed condition of the mucous membrane of the urethra and neck of the bladder may result from a stricture or from a long-forgotten gonorrhœa. The irritation of the prostate may be due to an abscess, a prostatic calculus, or a tumor affecting the part. Tubercular ulceration may affect the testicle, the vesiculæ seminales, the prostate, and the bladder. Spermatorrhœa is not by any means a common disorder. The majority of patients who complain are not suffering from spermatorrhœa, but from *prostatorrhœa*.[2] In some instances, nevertheless, spermatozoa are found in the discharge and in the urine. Paget found one case of true spermatorrhœa in fifty, and Kocher one in ten cases, of those who complained of the disorder. A contracted foreskin prevents the free flow of urine, and causes a good deal of pain and irritation; in children the parts become adherent, and confine the smegma preputii, and cause so much reflex irritation as to excite various nervous symptoms. The nerves of the anus and of the genital organs communicate freely, and are associated in the ano-spinal centre, or in the genito-spinal centre, of Budge, wherefore the rectum must be carefully examined for fissures, hemorrhoids, ascarides, etc. In some instances an abuse of enemata has induced an irritable condition of the neighboring organs. An irritable condition of the bladder, due to lithic acid or the administration of irritating medicines such as cantharides, will cause seminal emissions. Fear, anger, and intense mental strain are sometimes attended by a discharge. It has been already mentioned that continence is apt to induce spermatorrhœa in those predisposed to it. The urine in some cases is cloudy and extremely acid, and contains crystals of oxalate of lime, due to faulty digestion. Intermittent albuminuria may be the first symptom to lead the practitioner to suspect his patient of masturbation.

In a case under treatment the general health was good, but the patient, a man aged 35, was in a state of nervous trepidation because the time fixed for his marriage was drawing near. He had suffered years before from gonorrhœa, had been in the habit of indulging in moderate sexual intercourse, and had never had any reason to doubt his sexual powers. On becoming engaged to be married he became continent, and began to worry himself about a discharge which appeared whenever he went to stool; it varied in quantity, but was always present, even after taking aperient medicine. On examination, the fluid, as a rule, was free from spermatozoa, but now and then a stray one was to be found after a long search. His urine was cloudy and very acid, and contained crystals of oxalate of lime. A varicocele on the left side troubled him, and at his request was operated on. The operation was successful, and for a short time brought comfort, as he felt more sexual power. The condition of the urine improved, his general health remained very good, he ate and slept well, but the discharge continued daily, except now and then after the passage of a large metallic catheter. He had erections occasionally, and, after a visit to the seaside, had much improved. He foolishly attempted illicit connection, and, not succeeding, became more nervous and desponding. He would not be persuaded that he was not unfit to marry, and that the discharge was not semen, but prostatic secretion. He was treated with astringent injections and the passage of a full-sized silver catheter, but declined the application of nitrate of silver with Lallemand's porte-caustique.

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[1] Todd and Bowman, Physiological Anatomy, etc., vol. i. p. 362.

[2] See page 375, *supra*.

We are counselled by writers on the subject to gain the patient's confidence; in other words, we are to induce him to believe that on many points he is mistaken—a difficult matter when he is persuaded in his own mind that his case is desperate.

Pathological Anatomy.—But few post-mortem examinations have been made of persons suffering from spermatorrhœa, and then only in very advanced cases. Mr. Curling,[1] in one instance, found, on post-mortem examination, "that the mucous membrane at the prostatic part of the urethra was swollen and injected. The prostate was nearly destroyed and converted into a multilocular abscess, or a number of alveoli or cells communicating with each other; and the diseased mucous membrane covering it was riddled with holes, formed by a considerable enlargement of the original orifices of the gland, through which pus or altered secretion freely escaped on pressing the prostate. Both vesiculæ seminales were infiltrated with pus, and their walls thickened by inflammation. The orifices of the ejaculatory canals were enlarged and abraded." Pressure on the prostate by the passage of hard feces, or by the finger introduced into the rectum, gives pain. Although the irritation of the mucous membrane is not the original cause of spermatorrhœa, it excites the secretions of the testicles and a morbid craving for sexual indulgence, which is irresistible; it also acts as an excitant of the nerve-centres. Associated with the above changes may be found stricture of the urethra, inflammation of the bladder, and either hypertrophy or atrophy of the prostate.

Symptoms.—In some instances the penis is said to be large and hard, and the testes to hang low owing to the relaxation of the scrotum; but in many cases the condition of the parts displays no abnormality. Neuralgic pains affect the testes, which are small, soft, and very sensitive to the touch. Benedict states that the electric sensibility of the testes is lessened, and that the urethra is hyperæsthetic.

General symptoms follow after a time, and are chiefly referable to the nervous system. The nutrition of the body is interfered with, and the patient is anæmic, and falls into a low state of health, becoming thin and wasted, and indisposed to make any muscular exertion; even walking is attended with an effort. The face presents a peculiar, dejected look; the cheeks are hollow; the complexion is pale and pasty-looking; the skin yellow; the eyes sunken and surrounded by dark rings. The patient becomes morose and unsociable, indolent and unfit for muscular exertion, and unable to concentrate his mind on any subject; he is restless, irritable, and quarrelsome, and complains of impairment of memory. The digestion is disordered, and sleep is heavy and unrefreshing. After an emission, there is stiffness and pain in the back and limbs. The bowels are constipated as a rule, and there is at times difficulty in micturition. Motor disturbances, indicated by twitchings of the muscles of the extremities, are followed after a time by sensory symptoms, such as numbness of the spine and extremities, hyperæsthesia of the skin, and hot and cold sensations. The latter are sometimes so persistent that the patient will wear thick clothing, even on a hot summer's day. The special senses suffer, and the patient complains of affections of the eyesight—even disorganizing[1] changes in the vitreous have been occasionally noticed—and is troubled with buzzing, singing noises in the ears, and slight deafness. His taste and smell are perverted; he suffers from vertigo and headache, and, although not afflicted with insomnia, his sleep is troubled by erotic dreams; his mental depression increases; he becomes hypochondriacal, and devotes his waking hours to the contemplation of his unfortunate state, and to reading works on the sexual organs, written to entrap unfortunates like himself. If, as is likely to be the case, he has inherited a tendency to epilepsy or insanity, he may become melancholic, with suicidal tendencies. Epilepsy is very frequently associated with spermatorrhœa, the same condition of the nervous system which gives rise to the one disease predisposing to the other condition. Our lunatic asylums afford many examples of epileptics who, one and all, masturbate. Epileptic fits are kept up and intensified by this pernicious habit, although they may not be its immediate result, and castration has been performed for their relief.

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[1] Op. cit., p. 492.

Besides the above disorders, the patient suffers from irregular pulse and excessive palpitation of the heart, brought on by the least exertion or nervous excitement; a careful physical examination will show that organic disease is absent, a bruit, if present, being due to anæmia. Oppression of the chest, with dry cough and shortness of breath, but with no disease of the lung, is often associated with the palpitations. Dyspepsia is indicated by a feeling of distension of the stomach, tenderness on pressure, eructations, and sour risings. Seminal losses, when present in acute diseases, or in chronic, wasting diseases, such as phthisis, aggravate the attendant weakness.

Diagnosis.—If we submit a specimen of the suspected fluid to microscopic examination, we find spermatozoa present when the fluid is semen. The amount of semen secreted by healthy men varies, and it is diminished by frequent intercourse; the spermatozoa have been found to be absent in some instances, after excessive sexual indulgence, by Liégeois and Casper; this is a physiological condition, as the spermatozoa reappear in the semen after the sexual organs have had the requisite rest. The spermatozoa differ in number and development in normal semen, and in cases of spermatorrhœa the secretion is more fluid, while the spermatozoa diminish in number, and are not as well formed nor as active as in health. Membranous appendages adhere to the heads of the spermatozoa in some instances, and are, according to Kölliker, the remains of the parent cells. Small shining corpuscles are considered to be disintegrated spermatozoa on account of the presence of the remains of the tails, which are adherent to them.

Bence-Jones, Nepveu, and Beale have noted long, hyaline, worm-like bodies in urine; these from their size are thought to come from the deferent canals, as they are too large to originate in the tubes of the kidney or testicle. Under violent sexual excitement, a healthy young man may pass a drop of clear, sticky, inodorous fluid, free from spermatozoa, which comes from the various urethral glands (*urethrorrhœa ex libidine*). The fluid passed at stool after a costive motion, is an alkaline, albuminous secretion, free from spermatozoa, sticky, and inodorous; it comes from the prostate, and contains epithelium, a few crystals, mucous and occasionally pus corpuscles, and especially rounded amyloid bodies, which are considered by Pitha, Gross, and others, to be derived from the prostatic follicles, and to be pathognomonic of prostatic secretion. The presence of Böttcher's crystals is ascertained by mixing a drop of the secretion with a drop of a one-per-cent. solution of phosphorated ammonium upon an object glass. Numerous large beautiful crystals are shortly formed. The majority of patients who complain of spermatorrhœa are suffering from this prostatic discharge, and an examination by the finger introduced into the rectum often reveals a tender and enlarged prostate.

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[1] Nettleship, St. Thomas's Hospital Reports, vol. viii.

Prognosis.—Account must be taken of the family history of the patient; whether he come of a stock subject to nervous disorders, or even epilepsy or insanity; also of his general constitutional condition. A favorable result may be looked for when the patient is young, when the complaint is of recent date and unaccompanied by structural changes or general debility, when the necessary treatment can be carried out in all its details, when emissions associated with erections take place at night and awaken the patient, and when removable local causes—such as gleet, phimosis, varicocele, or diseases of neighboring parts—are present. On the contrary, when the patient is on the verge of forty, the complaint of several years' duration, the emissions frequent, induced by slight exciting causes, and associated with nervous symptoms and structural changes in the genito-urinary organs, the cure is at all times difficult. Men who indulge their animal passions in every conceivable way, instead of submitting to rigorous treatment, cannot hope for an amelioration, much less a cure of the complaint. In some instances the unfortunate habit of masturbation seems to be ineradicable; even married men with families, anxious to relinquish it, are unable to do so.

Treatment.—We have seen that spermatorrhœa is commonly due to masturbation and sexual excess. These habits must, therefore, be entirely abandoned. Infants suffer from frequent erections, caused by any irritation of the genitals, or the presence of a stone in the bladder. Children of all ages may be noticed handling their private parts when any irritation is present; they must be carefully watched, and bad habits instantly corrected. The supervision of children should not be suspended when they have left the nursery, but should be continued when they are at school, and any sign of masturbation should be at once investigated. Medical men, in the present day, are taking a more reasonable and scientific view of this question than formerly, and, instead of avoiding all mention of the practice, point out its evil consequences, and prescribe for its alleviation, removing by operation, if necessary, any mechanical cause of irritation. Masturbation, doubtless, is practised at some schools, and should be carefully watched for and repressed. Obscene literature and pictures, which stimulate the mind to indulge in impure thoughts, and cause sexual excitement even in the continent, are to be carefully avoided. An early and suitable marriage is the best preventive of the complaint we are now considering, but is not to be thought of unless the man be competent to discharge the duties of the marriage state, as ineffectual intercourse may entail on the wife various uterine and nervous disorders.

Failure of nutrition, due to neurasthenia, is in these cases a prominent symptom. We must, therefore, rely greatly on the internal administration of *tonics*, which act both on the nervous system and on the general health. Quinine is one of the most valuable remedies which we possess, and is to be given in tonic doses combined with hydrobromic acid. In cases of malarial poisoning, the dose is to be increased to the requisite extent. It may be combined with the mineral acids and sulphate of magnesium, and in some instances with the preparations of iron. Arsenic is also a valuable nerve tonic. The tincture of the chloride of iron is certainly one of the most valuable remedies which we possess for the treatment of disorders of the genito-urinary organs. The patient should begin with twenty drops in a wineglassful of water, taken three times a day after meals. The dose may be gradually increased until a drachm, or even a drachm and a half is reached. Some persons suffer from nausea, griping, and constipation after taking this medicine, which must then be left off, and resumed after an interval of rest. If intolerance still exist, the milder preparations, such as the potassio-tartrate, citrate, or dialysed iron, may be better assimilated. A visit to some health resort where ferruginous springs abound may be useful. Dilute hydrochloric acid, prescribed with the tincture, will neutralize its constipating effect. Strychnia, given in moderate doses and continued for several months, is a most useful tonic, and tends to regulate the action of the bowels. Ergot of rye, although most valuable in some cases, is not a specific. Dr. C. L. Mitchell[1] found ergot, in doses of one-half to one drachm daily, successful in several severe cases.

Sedatives and antispasmodics are most valuable aids in the treatment of this disorder. Camphor has been used from the earliest times, and must be given in full doses, from half a drachm to one drachm of the tincture, freely diluted with water, the last thing at night, and repeated if the erections prove troublesome and emissions threaten. Lupulin has been recommended by Professor Sigmund.[2] Mr. Milton, having tried it extensively in five-grain and drachm doses, taking care to secure the best hops, found that it was a pleasant bitter, but that it had only a mild and uncertain effect on the discharges.[3] Digitalin, the dose of which is from gr. $\frac{1}{60}$ to gr. $\frac{1}{30}$, has been administered for this complaint by M. L. Corvisart,[4] but, owing to its depressant action on the heart, is a dangerous remedy. Opium, given in grain doses, is a powerful sedative, and has held its ground as a valuable drug for the treatment of spermatorrhœa since its recommendation by Hunter, who cured cases by its exhibition. It should, however, be held in reserve as long as possible, as it is apt to disorder the digestion, and a habit of opium eating may be acquired. Chloral-hydrate, when tolerated by the patient, is very valuable, and is given in from ten-grain to thirty-grain doses. Professor Trousseau and others have recommended the use of belladonna, of which from a quarter to one grain of the extract may be given three times a day, or an equivalent dose of the tincture; the drug may be given also in the form of a suppository, or applied locally, if pain be present. Valerian, cherry-laurel water, and extract of hyoscyamus sometimes prove useful.[5] Dr. Nowatschek treats spermatorrhœa consequent on typhoid fever by hypodermic injections of a one-per-cent. solution of atropia in the perineum.[6] The bromides are, upon the whole, the most valuable remedies of this kind that we possess. Bromide of potassium may be given in full doses of twenty grains or more, three times a day. It may be usefully combined with chloral-hydrate. The bromides of ammonium, sodium, and camphor, the valerianate of ammonium, and the valerianate and oxide of zinc, are useful drugs.

The *digestive organs* are liable to derangements, which come and go, and intensify the symptoms by interfering with the nutrition of the body. The skin and bowels do not act properly; the tongue is coated; the urine scalds and is turbid; and the patient is not properly refreshed after a night's rest.

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[1] American Medical Monthly, April, 1861.

[2] Repert. für Pharm., No. 1, 1856.

[3] Practical Remarks on Treatment of Spermatorrhœa, etc., p. 55. London, 1871.

[4] L'Union Médicale, Avril, 1853.

[5] Medical News, Jan. 7, 1882.

[6] Wien. med. Presse, Bd. xx. S. 1067.

The usual blue pill, or colocynth and rhubarb pill, may be given in aperient not purgative doses, or the natural saline waters may be taken to the requisite extent. A diuretic, such as nitrate of potassium, and at times cubebs, copaiba, or sandal-wood oil, will prove useful. The diet should be carefully regulated: a sufficiency but not an excess of food should be taken, and it may consist of soups, fish, roast and boiled meat, and vegetables, with brown or whole-meal bread. Sound claret is the best wine to drink, but there is no objection to cold brandy or whiskey and water.

A remedy at once potent and pleasant is found in *change of scene and occupation.* A visit to a mountainous region where the air is bracing, the scenery magnificent, and the accommodation suitable, will prove most useful; at other times a visit to the seaside, with out-of-door exercise and bathing, will be more convenient. A visit to a hydropathic establishment, where the scenery and living are good, and where regular hours are kept and the cold-water cure is in full force, is often to be recommended. When, as is the case in some instances, the reaction is too great after the cold bath, and gives rise to a condition of irritability, bathing must be dispensed with. When obtainable at home, sea-water baths, or fresh-water baths with sea-salt added, especially if the spine be well douched, are invigorating. Sea-bathing, however, is not to be employed when the patient is debilitated or remains cold and depressed after it; if the feet are cold, they may be put in hot fresh water after the bath.

Trousseau employed, in cases of spermatorrhœa, both dry and wet cupping to the spine; in some cases counter-irritation by means of iodine-liniment and flying blisters are of service; moxas and cauteries have also been used.

The patient should sleep very lightly covered, in a cool room, on a hard bed. The most potent local sedative is the application of cold, which will keep the emissions in check if the patient will put up with the discomfort attending its use. An India-rubber bag, filled with ice, or a stream of cold water passing through a coil of soft metal pipes, may be applied to the part. Mechanical means are to be taken to prevent the patient from lying on his back or face. M. Trousseau's recommendation to apply warmth to the perineum, is useful in cases when there are pain and irritation. He extols the use of a metallic prostatic compressor, which is olive-shaped at one end, about the size of a pigeon's or hen's egg, and which tapers to the size of a small rectal bougie at the other. The olive-shaped extremity is introduced into the rectum, while the other portion projects from the anus, and is so fixed by a suitable T bandage that its upper end makes firm pressure on the ejaculatory ducts in the prostate, and so prevents the too ready escape of semen. Warning girdles awake the patient by means of sharp points, or are so constructed that an erection completes the circle of an electric battery, and sets an alarm going near the patient's head, and thus awakens him. The former kind are the more practical, and consist of a leather ring armed on its inner surface with steel spikes, and adjusted by means of a tape or buckle. The ring is regulated so that the points touch the flaccid penis; when the erection takes place the points prick with sufficient sharpness to awaken the sleeper, who should jump out of bed and bathe the genitals with cold water.

When the patient masturbates while half asleep, it may be necessary to tie his hands, so that he cannot reach the parts, or to blister the penis. Mr. Milton prevents access to the organ by confining it in a light wire cage. Blistering was esteemed by the late Mr. Hilton to be one of the most useful means of cure that we possess. The penis is enveloped in a blister, which should be applied in the daytime. Liquor epispasticus and strong iodine solutions are useful applications.

In some cases the urethra is very sensitive, the passage of a catheter causing spasm and pain, especially as it passes over the prostatic urethra; this irritability is lessened by passing full-sized, soft, olive-pointed bougies, which may be allowed to remain for a short time, and in some instances by using a full-sized, metallic instrument.

Cauterization of the prostatic urethra has been extensively practised since its introduction by M. Lallemand, who spoke highly of its merits. The instrument used is Lallemand's well-known *porte-caustique*, armed with nitrate of silver.

The application of this remedy causes some smarting and difficulty in passing urine, which is slightly tinged with blood; this, however, passes off if the patient takes a warm bath and keeps quite quiet. A warm bath and an opium suppository will, as a rule, relieve retention of urine, should it occur owing to neglect of the injunction to remain quiet, to avoid stimulants, and to partake freely of bland fluids. The cauterization is not to be repeated more than two or three times, at intervals of six or eight weeks. After the irritation caused by the application has subsided, a full-sized soft bougie may be passed, to correct any tendency to contraction that may exist. Patients complain, sometimes, of a tearing sensation when an emission occurs after the application of the caustic. When used in suitable cases, Mr. Curling finds that "it has rarely failed to afford more or less relief;" it must not, however, be expected to operate like a charm, but is to be associated with other remedies. After its application, patients have had hemorrhage, shivering, and retention of urine, and even cystitis and stricture have occurred in some instances. Retention is most likely to follow if a stricture be present, and the other symptoms if the caustic be too freely applied and quietude neglected. Instead of the application of the pure nitrate of silver, some use the salt diluted with nitrate of sodium to the desired strength. Some surgeons prefer to use a caustic solution. Diday[1] injects a solution of twelve centigrammes in eight grammes of distilled water; Kocher advocates a weaker solution, to be used more frequently; the solution may contain 1 centigramme to 30, 50, or 100 grammes of distilled water The fluid may be injected through a hollow sound, open at its end, by means of a suitable syringe. When introduced into the bladder, the instrument allows urine to escape; it is then withdrawn into the urethra, when the fluid will cease to flow; as soon as the end has passed the tender spot in the prostatic urethra, the instrument is to be withdrawn no further, but a drachm of the caustic solution is to be projected into the passage and allowed to remain there for a few minutes. A slight burning sensation, which lasts for an hour or two, will be felt. The application of a caustic solution is very efficacious, and more exact, and in some respects safer, than the use of the caustic-holder, as the latter has been known to break and leave its end in the urethra. Other caustic and astringent solutions have been employed, but nitrate of silver is by far the most valuable.

The *electrical* treatment of spermatorrhœa and impotency has been much advocated of late years. Duchenne recommended the application of interrupted currents (faradic) in some cases of spermatorrhœa. Mr. Curling has found this suggestion useful, especially in some cases of impotency, where the desires are strong but the erections feeble and non-persistent. Schulz[2] and Benedict[3] employ exclusively the constant current. Schulz applies the positive pole of a battery containing from 20 to 30 of Daniell's elements to the spine, and the negative pole to the pubes or perineum; three or four applications, each lasting for two minutes, are made weekly, and tend to lessen the reflex excitability of the cord. Benedict also employs the constant current, placing the copper pole over the lumbar region of the spine, and passing the zinc pole to and fro over the spermatic cords, penis, and perineum. The currents used are so weak that they are only just perceptible, and they are applied daily for two or three minutes, the treatment lasting for two or three months. When galvanic catheterization is deemed necessary, the copper pole is made into a sound and introduced as far as the prostatic urethra, the zinc pole being passed backwards and forwards over the spermatic cords; three applications in a fortnight are sufficient. When the skin is cold and anæsthetic, the galvanic brush is of use.

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[1] Annuaire de la Syphilis, etc., 1858.

[2] Wiener med. Wochenschr., No. 34. 1861.

[3] Oesterr. Zeitschr. für prakt. Heilk. Bd. x. H. 3, 4. 1864; and Electro-therapie, S. 446–99.

Castration has been advocated, especially in cases associated with severe epileptic attacks, and men have even been known to perform the operation on themselves. The opinion of the profession is against the performance of this operation for spermatorrhœa, for the treatment of which many better remedies are available. The patients who demand the operation, which is by no means a certain cure, or who perform it on themselves, are often monomaniacs, and should by no means be gratified in their whim by the surgeon. Mr. Curling mentions the case of a gentleman who, after the removal of both his testicles by a surgeon, committed suicide. Instead of castration, it has been proposed to attain the same end by ligation of the spermatic arteries—a milder proceeding, but one not to be recommended.

The following interesting cases have been kindly communicated to me by a gentleman who has been a superintendent of a large public asylum for many years, and who may justly be considered an authority on the subject under our immediate consideration :—

> A case of removal of both testicles occurred when I was in charge of a county asylum about twenty years ago, and the facts were these : A masturbating young man who had become almost demented, and who was gradually failing both in mind and bodily health, received a severe injury from a kick by another patient; the whole force of the blow came upon the testicles, producing swelling and hæmatocele. Inflammatory mischief afterwards set in, and the testicles became affected with what I suppose must have been scrofulous disease, judging from the general health of the patient. Thinking that I might get rid of two evils at the same time, viz., masturbation and the diseased testicles, I removed them. The patient was put upon extra diet and cod-liver oil, and soon recovered. Before the operation he had been much emaciated, and, as I have said before, almost demented, unable to do anything, and a most miserable object. After he recovered from the injury, he got fat and became much more intelligent, so much so that he was able to follow his trade as a tailor, and he continued to improve mentally for about six months, when he succumbed, after a short illness, to an attack of pneumonia. Judging from the result of this case, I have always thought that it is a great pity that castration could not be more frequently adopted in cases of mental disease, the result of masturbation. Such cases fill our asylums with hopeless imbeciles, and I look upon all other methods of treatment, such as blistering the penis, etc., as perfectly useless.
>
> I know of a case in this town in which castration was performed upon the son of a tradesman with perfect success, as far as curing his mental state was concerned. The father of the patient consulted me about his son, who was mentally affected, and who was gradually getting worse. I told him what I believed would cure him, but, as I had only recently come to the town, and did not like to take the responsibility of the case, I refused to perform the operation, although the father wished it to be done. At his request, two old-established practitioners in the town did it, and the result was the perfect recovery of the young man, who for some years past has carried on business with his father

The above cases deserve our careful consideration, as the mental and bodily condition of both patients was materially improved at the cost of organs useless for the purpose for which they were designed. The peculiar condition of the patient's mind, in each individual case, must necessarily be carefully taken into consideration.

It is fortunate when the cause of urethral or other irritation is due to some local change which is easily removable; among these causes we find congenital phimosis, stricture of the urethra, and occasionally varicocele. Infants with tight foreskins should be circumcised, as they are in a constant state of irritation, which causes erections; an adherent foreskin, even if there be no phimosis, may imprison a quantity of secretion, and give rise to reflex irritation and difficulty in passing water—in fact, to the symptoms of stone in the bladder. Circumcision renders the glans less sensitive, and the circumcised are less liable to masturbate and to suffer from balanitis or epithelioma. Varicocele in some instances is associated with spermatorrhœa. Ravoth, in a case under his care, effected a cure by means of a pressure apparatus.[1] Strictures of the urethra are to be dealt with in the ordinary way.

Dr. Pooley reports[2] a case of spermatorrhœa which resisted all the usual methods of treatment, but was cured by cystotomy, the incision being made at the apex of the prostate gland. A silver tube, with India-rubber tubing, was introduced through the wound. A patient who requested me to perform a similar operation on him, was relieved by the application of strong iodine paint to the perineum and hypogastrium. Care must be taken lest the patient prove to be a monomaniac.

Impotence and Sterility.—*Impotence* and spermatorrhœa are so closely associated that most of what has been said on the latter subject is applicable to the former, the etiology, symptomatology, prognosis, and treatment being the same. Impotence is present when the power of sexual intercourse is diminished or completely lost. If the failure be not due to congenital or acquired defect of the organs, it will be owing to erection lasting too short a time, or to its being altogether absent. In most cases, men who are impotent are also sterile, although their testicular secretion may be fruitful, the exception being when in spite of a mis-emission the woman becomes impregnated. For a satisfactory erection the presence of one or both testicles in a normal state is essential. The carefully recorded cases of Sir Astley Cooper and Professor Humphry show that after castration the power to copulate is slowly lost. For the due performance of coitus are needed: (1) Sexual excitement or desire. (2) Erection, the reflex effect of desire. (3) Voluptuous ejaculation whilst the penis is erect (Schulz). This requires the normal action of certain muscles and a normal sensibility of the glans. The nervous excitement may be furnished by irritation of the nerve-trunks in their course, or at their periphery at the glans or the integument of the penis; or it may originate in the nerve-centres.

From Eckhard's valuable researches we learn that the *nervi erigentes* are two in number, one on each side, and that in the dog they arise from the sacral, and are lost in the hypogastric plexus. He concludes that the fibres which convey the impulse required for erection arise in the cerebrum, and pass down through the crus and pons to the spinal cord; because by electrical stimulation of the pons, and of the point at which the crus cerebri enters the brain, he produced distinct erection of the penis. Erections were caused also by stimulation of the upper cervical region, or of the lower section of the divided lumbar portion. Goltz assumes that an independent centre for erection exists in the lumbar region of the cord, and that it may be acted upon inhibitively from the upper part of the medulla oblongata, and still more from the brain; because he found that when the influence of the brain and upper part of the spinal cord was removed, by dividing the cord, erection was produced more speedily and completely. In a case of injury to the spine in the upper portion of the dorsal region, which occurred in a young man, there was paraplegia, and such an irritable condition that the mere passage of a catheter caused violent erections. After injury to the spine, priapism is often present, as also in some cases of spinal disease. The terminal filaments of the nervi erigentes are distributed to the corpora cavernosa, as are also branches of the pudic nerves; neither section of the latter, nor irritation of their peripheral stumps, appears to cause any change of a marked or constant character in the penis, since they serve merely to transmit the centripetal stimuli by which the act is normally provoked. The erector nerves may be cut without any appreciable consequence, but when their peripheral ends are stimulated by an interrupted current, the corpora cavernosa become turgid with blood. The erection, however, is not complete, the turgescence being most marked at the bulb and least so in the glans penis. If an incision be made into the corpora cavernosa, the blood issues more rapidly from the cut when the nerves are irritated, and is of a brighter color. The pressure in the efferent veins is simultaneously raised. That these phenomena are really due to dilatation of the arterioles supplying the erectile tissue with blood, and not to any hindrance offered to the escape of blood by compression of the efferent veins, has been adequately proved by Eckhard, Lovén, and others. Ligature of all the efferent veins is not enough, *per se*, to produce erection; moreover, partial erection may be caused by electrization of the nervi erigentes, even when the efferent veins have been freely opened. The retarded efflux of blood plays an important but subsidiary part in the causation of erection. When the penis is erect, the meshes of the corpora cavernosa are distended with blood, owing to a disproportion between the blood entering the part and that leaving it. Arterial blood enters more abundantly during erection, and there is found to be a diminution of arterial pressure in all the pelvic vessels, and in the crural arteries. (Eckhard.) The turgescence is caused by increased cardiac action, but principally by the greater permeability of the arteries of the penis, due to the nervous condition. The dilatation may be active, that is, caused by an arrangement of muscular fibres; or it may be passive, and due to their relaxation. (Hausmann.) The diminished outflow of blood is ascribed by Kölliker and Kohlrausch, not to the veins themselves, but to the influence of the nervi erigentes on the unstriped muscular fibres of the cavernous tissue; these become relaxed, and allow the blood free entry to the part. Erection begins at the base of the penis, and extends forwards to the glans. During erection, the veru montanum becomes distended and prevents the semen from flowing backwards into the bladder; the semen's passage outwards is facilitated by the patent condition of the urethra, due to the distension of the corpus spongiosum, and by its lubrication with the secretions afforded by its glands.

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[1] Berlin. klin. Wochenschr., 1874-75.

[2] New York Medical Times, Sept. 1878.

Malformations and defects of the genital organs, leading to impotence, may be congenital or acquired. The penis may be absent, may have been dislocated, or may have been removed by accident, sloughing chancre, or the surgeon's knife. In some instances the penis is small and ill-formed; or the urethra may be misplaced, its orifice opening improperly. Instead of being too small, the organ may be too large, from over development, or from elephantiasis affecting its integument. Intercourse with emissions may take place after the removal of the glans penis, the irritation of the nerve-twigs supplying the skin of the penis being sufficient to cause an ejaculation of semen. The penis is often effectually buried in cases of large hernia, hydrocele, or scrotal elephantiasis; and occasionally tumors of the penis are present, which render sexual intercourse impossible. A distressing defect arises in some middle-aged men from deposits in the corpora cavernosa causing indurations, which block up some of the cells and cause a bent and painful state of the penis when erect, owing to its unequal distension with blood. Deposits may be due to the accidental or intentional rupture of the corpora cavernosa when the penis is erect; in one instance it followed the forcible dilatation or rupture of the urethra for organic stricture.

Malgaigne and Velpeau have described cases in which ossification of the fibrous sheath or septum of the penis had taken place, and have reported favorable results from operation. At times the penis is curved when erect, owing to a shortened condition of the frænum, or it is confined, owing to a webbed condition binding it down to the scrotum. This is to be remedied by a division of the frænum, or a suitable operation on the web. Just as impotency follows castration, so the same condition will result when the testicles undergo atrophy from any cause, or when they are extensively invaded by new growths. The flaccid condition of the gland, so often associated with varicocele, does not affect virility to any extent; but Vidal (de Cassis) records the case of a young man who had suffered from his earliest years from a large, double varicocele, and who, after its radical cure, lost his high-pitched voice and recovered all his masculine attributes; the venous congestion was relieved by the operation. In Wardrop's well-known case, arterial anæmia ensued, and atrophy of both testicles took place, owing to the pressure exercised by a large aortic aneurism on both spermatic arteries at their origin. Cryptorchidism of both testicles, when they are atrophied, is attended by impotency, but the power of copulation exists when the testes are in the inguinal canal, and even may do so when they are in the abdomen, although there is then a very strong presumption that spermatozoa are absent, and the semen therefore sterile.

When the testes are completely atrophied from an early age, or have entirely disappeared (anorchidism), the bodily conformation will be womanly, the penis will be undeveloped, and the individual will be destitute of sexual instincts. Cases of hypospadia with cleft scrotum, when the testicles are not to be felt externally, but are hidden within the abdomen, often pass as instances of hermaphroditism.

The stunted penis is capable of erection, and imperfect sexual intercourse can be had, but the discharge will not be deposited in the vagina, but will be spilt externally. The researches of Godard have demonstrated that when double blennorrhagic epididymitis has occurred, and has left deposits behind, the semen is destitute of spermatozoa, and the patient is consequently rendered sterile, although the power to copulate is unimpaired. Orchitis proper, or acute inflammation of the substance of the testicle itself, following an injury or an attack of mumps, is liable to be followed by wasting of the organ and destruction of its function. Chronic inflammation of the testes gives rise to azoöspermia. Injuries to the head and spinal column are at times followed by atrophy of the testicles. In some instances a testicle may waste without any assignable cause, and in some cases the atrophy has been attributed to an affection of the larynx (Meckel), or of the tonsils (Verneuil). In some few cases wasted testicles have been found associated with large hydroceles and hæmatoceles of long standing, the wasting being attributed to pressure. In many acute diseases, and in those attended with much pain, the patient is much debilitated and sexual desire is in abeyance. In chronic Bright's disease sexual power is diminished, and in diabetes, in some instances, its failure is observed at an early period. In tabes dorsalis the spinal cord is affected in the region occupied by the genital centre, and we consequently find that sexual excitement with priapism is sometimes an early symptom, and one which eventually gives way to impotence. Troubles of digestion give rise to acid deposits in the urine, and in some instances to impotency.[1]

Some writers assert that in cases of pulmonary phthisis, sexual power and desire are retained. Godard makes the interesting and important statement that sterility may precede by two or three years the apparent development of tubercle of the testicle. Those, he says, who have but one testis affected are sterile, though not impotent, their semen being deprived of spermatozoa.

Certain drugs are said to act as anaphrodisiacs. Among these we find mentioned camphor, bromide of potassium, lupulin, and arsenic. Roubaud mentions that a man, aged 27, used inhalations of iodine vapor for six or eight months for the treatment of pulmonary phthisis, and that he suffered the total loss of his testicles. After a certain age frigidity sets in, but the exact time varies in different men. M. Duplay has found lively spermatozoa in the semen of old men, and men very advanced in years have begotten children. In warm climates, where the abuse of the sexual organs has commenced in early life, and has been continuous, men are not infrequently impotent at thirty years of age. A form of impotence to which the term psychical has been applied, is met with in the newly married. A man who has been in the habit of indulging in sexual intercourse becomes engaged to be married, and ceases to have irregular sexual relations; when married, he finds to his dismay that, owing to excessive excitement or nervousness, he fails the first time that he attempts to have connection. This worries him to such an extent that he remains unable to consummate the marriage rite, although during the time of engagement, and at other times after marriage, when the opportunity for coitus is not present, he may have satisfactory erections. This condition occurs in the continent, but more often in those whose powers have been weakened by masturbation or excess. Hunter cured one such patient by making him promise faithfully not to attempt to have intercourse until he had taken a stated number of pills. The man failed to keep his promise, but was cured of his impotency, which was due to mental causes. In another case a middle-aged man, who had been used to moderate sexual indulgence, married, and, failing to consummate the rite, became very despondent, but was cured by the exhibition of medicines which stimulated the sexual organs; he did not, however, effect coitus satisfactorily until his wife had submitted to division of the hymen, and to dilatation of the vagina by means of a bougie. Belonging to this same class of cases are those occasionally met with, where the man is unable to have intercourse with his wife, owing to a feeling of repugnance, or a want of sexual affinity. In those cases of irritable weakness already alluded to, which are often due to masturbation, there is intense desire accompanied by an erection, which subsides before intromission, or does not last long enough for complete connection. The popular belief that coitus, in order to be satisfactory and to be followed by impregnation, should last a certain time, and that the act should be consummated by the orgasm occurring simultaneously in both man and woman, is founded on a physiological basis, since the reflex action favors the entry of the seminal fluid into the cavity of the uterus.

The permanent or paralytic form of impotence is of great gravity; in this variety erections are absent; it is generally due to sexual excess, especially to masturbation. In some instances there is anæsthesia of the scrotum, which is relaxed, pale, cold, and pendent. The parts may be under-sized, the testicles being small, and softer than usual, with a diminution or absence of testicular sensation.

A cautious *prognosis* should be given; in some instances there is no outward sign to show that virile power is absent, the patient being endowed with a robust person, a manly voice, and hair on the face and pubes; on the other hand, the conformation of the body may be womanly, and the genitals relaxed or undeveloped. The congenital variety of paralytic impotence exists, but is very rare. Sir A. Cooper says, that "some men are so constituted that they may be said never to possess a venereal stimulus, and some of the other sex are equally frigid."

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[1] C. H. Ralfe, Morbid Conditions of the Urine, etc., p. 109. 1882.

Treatment.—When the penis is buried in a large swelling—hernia, hydrocele, elephantiasis scroti, and the like—it may be released by a suitable operation. Tumors or overgrowths of the integument of the penis are to be dissected off when possible. Distortions of the penis, due to deposits in the corpora cavernosa, have been operated on, but with scanty success. Velpeau[1] advocates the removal of the ossific deposits which are sometimes found in the penis.

Cases of psychical or hypochondriacal impotence should not be treated by electricity, but by tonics, change of air, and abstinence for a time from all attempts at coitus. In cases of weakness from continence, on the other hand, regular coitus will effect a cure. When there is irritability of the organs, the use of astringents and the passage of a sound are advisable. The paralytic forms of impotence are the most grave. In the congenital variety, stimulating remedies, such as cantharides, phosphorus, nux vomica, and ergot of rye, may be tried, but in the acquired form of paralytic impotency, nervous irritability is present, and all stimulating remedies and sexual intercourse should be avoided. Tonics, baths of various kinds, and the application of galvanism, should have a fair trial.

Sterility is said to be present when fertile semen is absent, or when it is not normal in composition, owing to the absence of spermatozoa. When *aspermatism* or *aspermism* is present, coitus takes place naturally, but without a seminal emission resulting. *Azoöspermia* exists when coitus takes place and results in an emission, but when on examination by the microscope the fluid is found to be destitute of zoösperms, the essential element of fecundation. Schulz places in one class cases of *permanent or absolute aspermatism*, due to local causes. The power to emit has in these cases been absent from birth, or, if lost subsequently, has never returned. In another class are placed cases due to some affection of the nerve-centres, the *aspermatism* being *temporary*, or *relative;* coitus is attended, generally, with emission, though under certain circumstances emissions are absent.

In cases of absolute aspermatism, the semen is shut out from the urethra itself, or is prevented from escaping properly from the penis by a stricture or very tight foreskin. The entry of semen into the urethra may be prevented by obstruction of the common ejaculatory ducts. Obstructions in the vasa deferentia or epididymes, also, give rise to the absence of spermatozoa in the emitted fluid. Prostatic changes due to disease or injury may prevent the entry of semen into the urethra; or the semen may enter the urethra, and, owing to some local change, pass backwards into the bladder, or be imprisoned in the canal by a stricture, escaping after the subsidence of the erection. The urine contains semen under these circumstances. Gonorrhœa is a common cause of stricture, and of this condition. Changes at the sinus pocularis may cause obstruction, or diversion of the semen into the bladder.

Hirtz mentions the case of a married man who had connection without emission, the urine passed afterwards being clouded with semen. On one occasion, during coitus, some obstruction, which was probably due to an old gonorrhœa, gave way, with smart bleeding. The spermatozoa reappeared in the semen, and the patient's wife became pregnant.

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[1] Nouv. Élém. de Méd. Opérat. Paris, 1839.

M. De la Peyronie records the still more interesting case of a man, the father of three children, who contracted a gonorrhœa, which he neglected. He ceased to ejaculate during coitus, the secretion being retained, and flowing away on the subsidence of the erection, but the free passage of the urine showing that no stricture was present. The man died, and on post-mortem examination a cicatrix was found in the portion of the veru montanum which looked towards the bladder. A cicatricial bridle had changed the direction of the ejaculatory canals, causing their orifices to look backwards, and the semen to be projected towards the bladder instead of forwards into the urethra.

Changes in the prostate, due to gonorrhœal inflammation, abscess, or prostatic calculi, may be an obstacle to the entry of semen into the urethra. The absence of spermatozoa, from cicatrices consequent on the lateral operation of lithotomy, has been noticed by many writers on the subject. Congenital defects of the vasa deferentia, prostate, or vesiculæ seminales, may cause the absence of normal semen (azoöspermia). Some cases differ from the above, in that the patients have connection without emission or the sensation of emission at the time, but have seminal emissions with the usual sensations during sleep. The act of intercourse may be continued for an indefinite length of time without emission, a state of erection having continued throughout, or having subsided before the withdrawal of the penis. These cases are free from any local lesions, and are due to a fault in the conducting nerves, or in the nerve-centres themselves. Schulz thinks that the centre for erection and emission is the same, and that a more intense excitement is necessary to produce an ejaculation than to produce an erection.

Temporary or *relative* aspermatism, a rare condition, is present when a man is unable to emit under certain circumstances and at certain times. Güterbock, recognizing the likeness between this condition and that already mentioned in which a man is impotent only when certain women are concerned (psychical impotence), aptly calls this state *psychical aspermatism.*[1] Schulz considers that this state may be due to a spasmodic condition of the seminal passages, particularly of the ducts and vesiculæ seminales, whereas Curschmann favors the idea that it is due to the inhibitory action of the cerebrum over the centre for erection. Stricture of the urethra, or any cause which prevents the egress of the semen, should be removed by suitable treatment, but in many cases little can be done. Cases of absolute congenital aspermatism, occurring in men apparently healthy, are incurable. The cases of so-called psychical aspermatism are to be treated by tonics and change of air, and, on the recommendation of Schulz, the constant current may be cautiously tried.

Azoöspermia is a condition which has been ably described by M. Gosselin. The subject of this condition is sterile, because, although connection and emission take place as in health, there are no spermatozoa to be detected in the discharge. The spermatozoa are absent because they are not formed by the testicles, or, if formed, are imprisoned in the excretory tubes, and do not reach the urethra. An occlusion taking place on both sides of the epididymis or vas deferens, will prevent the arrival of spermatozoa at the vesiculæ seminales and their admixture with the secretion of the vesiculæ, which alone is discharged into the urethra; the occlusion is on the distal side of the common ejaculatory duct, which, under these circumstances, only conveys the secretion of the vesiculæ seminales. When the obstruction is of the common ejaculatory ducts, or of any part of the urethra, the condition of *aspermatism* is induced, as has already been described. Inflammation, most commonly due to gonorrhœa, may affect the vas deferens, or the epididymis, giving rise to epididymitis, and may unfortunately cause an obliteration of the excretory ducts. If both testicles be present, the inflammation must take place on both sides to cause the disappearance of the zoösperms. Inflammation arising from traumatic causes will be more likely to cause extra-tubular deposit than gonorrhœal inflammation, which travels down the tubes, starting from the prostatic urethra. The prognosis is therefore more favorable in the former than in the latter case. Out of eighty-three cases of bilateral blennorrhagic epididymitis tabulated by M. Liégeois, he found that the spermatozoa reappeared in only eight cases. The disappearance of the induration of the epididymis is a good sign, as it generally, but not always, indicates a return of fertility; in cases in which the deposit is due to an ordinary inflammation, the spermatozoa may pass in spite of the induration (Curling). The secretion of the testicle, which is not suspended, may cause a dilatation behind the obstruction, and a sensation of discomfort when coitus is indulged in.

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[1] Canstatt's Jahresbericht.

Professor Billroth[1] has never seen tubercular nodules disappear spontaneously, and considers them to be incurable:—

> Once only, at the urgent request of a patient, a strong man who had become impotent, and who had been told by his medical attendants that the condition was due to the pressure of the nodules on the vas deferens, Billroth consented to operate without holding out any great hopes of a successful issue, because simple pressure on the vas deferens is but rarely met with; generally the larger spermatic ducts and epididymis are involved in the degeneration, and are thus rendered impermeable. He laid open the scrotum on both sides, drew out the testes, carefully removed the nodules, replaced the organs, and then sewed up the wounds in the scrotum. The operation was done with antiseptic precautions; the parts healed by the first intention, but the ultimate result in restoring function was not known, as the patient was lost sight of.

A specimen in King's College Museum shows obliteration of the vas deferens by a cyst full of cheesy matter, which communicated with it, about an inch above the epididymis. Such a case might, under certain circumstances, be considered amenable to operation.

Where there is no sterility, the surgeon should not interfere, as some of the ducts yet pervious might be injured. In cases in which the testes are absent or atrophied, or in which their secretory tissue has been destroyed by the presence of new growths, spermatozoa will be absent.

Temporary azoöspermia, in contradistinction to the above-described condition, which may be considered *permanent*, may be present in certain diseases; and, as already remarked, according to Casper and Liégeois, men in good health may, after excessive sexual indulgence, excrete semen destitute of spermatozoa, which reappear when the organs have had the necessary physiological rest.

SATYRIASIS.—The term satyriasis signifies a morbid exaggeration of the sexual appetite in man. The desire to indulge in the sexual act is irresistible and insatiable, and a faculty of exercising it a great number of times is possessed by the affected individual. Women suffer more often than men from this unfortunate condition, which with them is called *nymphomania*. It is a symptom of disease elsewhere; in fact, a form of madness or impulsive monomania. A chronic cerebral affection will give rise to *erotomania*, which has for its starting-point a disorder of the cerebral functions, the imagination only being at fault; but in satyriasis the source of evil is in the reproductive organs. Men with perversion of the intellect may at any time become frenzied, and be ruled by their instincts, and these may impel them to commit unlooked-for extravagances which land them in an asylum or a prison. Infancy and old age furnish examples of satyriasis, but it is more common during the period of the greatest activity of the sexual functions, and at the advent of puberty, when nerve storms are so apt to occur. Men suffering from hydrophobia may have violent sexual desires with prolonged erection of the penis. Dogs attacked by rabies have also been observed to suffer in the same way. As a rule, an attack of satyriasis runs an acute course, and, unless induced by a poisonous dose of phosphorus or cantharides, is not fatal; when so caused, a post-mortem examination will reveal congestion of the genito-urinary tract, and of the cerebro-spinal apparatus. Idiots suffer from a chronic form of the complaint, and when moved to sexual indulgence are troublesome, and will take every means at their command to accomplish their desires. In congestive mania, at times, the sexual desires are unrestrainable. A man with a family, and of blameless life, will throw off all decency, use bad language, openly consort with immoral women, and, unless deprived of his liberty, will commit some criminal offence. Old men, weak in mind and body, suffering from some brain irritation caused probably by atheromatous arteries, will suddenly develop an attack of satyriasis or lechery, and, becoming lost to all sense of shame, will seek to gratify their sexual appetite in public, on persons of the other sex, and even on children of tender years. Highly educated men, with an hereditary tendency to insanity or epilepsy, leading a lazy, self-indulgent life, are those likely to be attacked, and, rushing from one extreme to the other, from being chaste become profligate. After repeated attacks of satyriasis a condition of stupor of the sexual sense may be developed. In a late stage of general paralysis of the insane, the patient has erotic impulses, to which the sexual organs refuse to respond. The administration of phosphorus or cantharides to a person predisposed to satyriasis, may induce a most violent and dangerous attack. At the onset, moderate doses of alcohol and opium will produce sexual excitement, but eventually they will induce impotency.[1]

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[1] Clinical Surgery, New Sydenham Society's Translation. London, 1881.

A young woman of respectable family and well conducted, with the exception that she gave herself up unaccountably to the indulgence of her salacious temperament, died, and presented on post-mortem examination a hydatid cyst which occupied the right crus cerebri, the cerebellum, and the upper part of the spinal marrow, and which excavated the pons Varolii.

If the sexual propensities be checked by a strong effort of the will during the hours of wakefulness, voluptuous dreams and images will haunt the patient when asleep, and eventually the attack will culminate in an onset of frenzy, during which the demoniac, if unable to satisfy his sexual desires on one of the opposite sex, will ravish animals, and even dead bodies. He knows no restraining power, as he is lost to all sense of fear.

Causes.—The most common predisposing cause of the complaint is a hereditary predisposition to insanity or epilepsy. Epileptics must be carefully watched lest they criminally assault their companions. Any disturbance of the nervous system, or a local irritation of the penis or scrotum, such as phimosis and adherent prepuce, eczema, or prurigo, by causing a flow of blood to the part—or continence, by preventing the physiological discharge of the secretions—may start the complaint. The disease may also be induced by exciting the imagination by reading obscene books, by witnessing lewd performances, or by masturbation. Satyriasis is present sometimes in the early stage of priapism. The unfortunate victims of leprosy have been unjustly accused of erotic propensities, but Sir Erasmus Wilson says that they are innocent of the charge, although for their supposed lasciviousness they were called satyrs.[2]

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[1] Med. Times and Gazette, Feb. 15, 1862.

[2] Lectures on Dermatology. London, 1871–3.

In one case a blow on the neck led to a violent attack of satyriasis, which lasted three months. Cerebral symptoms were present, and the man died.

M. A. Motet has collected some interesting cases of satyriasis:—[1]

The curé of Cours, a man aged 32, when strenuously endeavoring to lead a religious life, was attacked by strong sexual feelings. He repelled the promptings of desire in the day time, but at night was haunted by lascivious dreams and frequent pollutions. He starved himself to repress his desires, but in spite of this he awoke one morning, his imagination warmed by voluptuous images, and his organs of generation much excited. He became delirious, saw fantastic visions and women in lascivious positions, and finally, succumbing to the promptings of his diseased imagination, a scandal ensued.

Cases are mentioned by Ambroise Paré,[2] Cabrol, and others, of men who had been poisoned with cantharides. The victims suffered from intense venereal excitement, and had sexual intercourse, repeating the act furiously an incredible number of times. Several of the patients died with gangrene of the penis. A strong young man received a blow on his head, which was followed by cerebral disturbance. When to all outward appearance sane, he set fire to several houses, and eventually strangled and then ravished a child seven years old. In some instances cerebral symptoms come on with delirium, and end in death. A tumor was found after death in the brain of a medical man who was much addicted to lechery.

A handsome, old, married clergyman, a schoolmaster, and a ripe scholar, suffered from an attack of lechery. He used to narrate his many conquests, which were purely imaginary, in the master's common room, and was eventually dismissed, owing to complaints by some of the boys that his language was improper. The dismissal so preyed on his disordered mind that he shortly after destroyed himself.

Professor Gross attended a young medical man, convalescing from an attack of fever, who indulged so freely in sexual intercourse that in consequence of his enfeebled state he died.

Treatment.—The excretory functions of the body should be carefully attended to, and the various sedatives administered which are recommended for the treatment of priapism. A course of hydropathic treatment is likely to prove useful. Insane persons with erotic tendencies appear to the uninitiated to be needlessly detained within asylum walls, but those acquainted with their histories know their evil propensities too well to recommend their discharge.

PRIAPISM.—Cases of priapism are recorded in the medical journals from time to time. In some there is a history of an injury to the part, and extravasation of blood, the accident often happening to a tipsy man indulging in sexual intercourse. In others, however, the cause is not at all evident, as there is no history of an injury; it has been noticed after excessive coitus. In some instances sexual desire has existed for some time, but as a rule the erection is attended by uneasy sensations, and even by severe pain. Some cases are due to extravasation of blood, and others are attributed to nervous reflex irritation.

Mr. Bryant circumcised a boy aged two years, who was suffering from an erection of the penis which his mother declared positively had existed from birth. He could pass his water freely, but the prepuce was long and adherent to the glans. When eleven months old he had had tetanic fits, followed by wasting of his legs. The operation removed all the symptoms.

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[1] Nouveau Dict. de Méd. et de Chir. Prat., t. xxxii.

[2] Œuvres complètes, t. iii. p. 327.

Mr. Callaway's patient, a man aged 44, had connection with his wife when he was intoxicated, and injured his penis. The priapism remaining unchanged for sixteen days, Mr. Callaway opened the left crus penis, and evacuated a large quantity of dark grumous blood and small coagula. The patient was well in a few days.

Mr. Tripe's patient, a sailor aged 26, after frequent connection had priapism, which lasted for four months. In Mr. Luke's case, the blood became absorbed and the organ restored. A patient under Dr. Handfield Jones's care suffered for one month, when the corpus cavernosum on one side was incised.

A laborer, aged 44, had injured his penis during coitus, and, when admitted into Guy's Hospital, had suffered from persistent priapism for ten days. For a week he had felt passionate venereal desires, which had then left him. The corpora cavernosa were chiefly affected, for the glans penis and corpus spongiosum were not turgid. The man suffered such severe and constant pain that Mr. Birkett incised the corpora cavernosa in two places on both sides, and evacuated some dark, thick blood. Warmth and moisture were applied. Mr. Birkett recommends treatment without incision in similar cases.

Erection of the penis is caused by irritation of the spinal cord or its nerves, and occurs most frequently at night, but sometimes by day, in cases of myelitis or congestion of the spinal meninges. It is observed, but less frequently, in cases of meningitis, of tumor pressing upon the spinal cord, of hemorrhage into the spinal canal (outside of the cord), and sometimes even of reflex paraplegia, but then only on the introduction of a catheter, or in consequence of some peripheric irritation. This symptom does not exist in cases of non-inflammatory softening, or of hemorrhage, or of tumor in the gray matter of the spinal cord. Hunter says that priapism often threatens mortification in man, and he saw one instance of the kind in a dog; the erection never subsided, and the glans penis could not be covered by the prepuce from the swelling of the bulb; the penis mortified and dropped off.

As opium is of very great service in priapism, there is reason to suppose that the complaint is, in some cases, of a spasmodic nature.[1]

Kremme believes that effusion of blood into the corpora cavernosa is caused by the impeded return of the blood in persons suffering from leukæmia, and corresponds to the bleeding from the nose and rectum which sometimes occurs in that affection. Longuet regards the physico-chemical condition of the blood in leukæmic patients as the cause of the priapism, and considers that the circulation of the blood is hindered in the smaller vessels, whilst thrombi are formed owing to the great increase in the number of white blood-corpuscles. Neidhart and Matthias conclude that the origin of the affection may be sought in the disturbance of the nerve-centres.

Dr. Salzer, of Worms, narrates a case of priapism in a man aged 46, who awoke with his penis in a state of violent erection which even the administration of chloroform did not allay. He considers this condition to be one of the symptoms, but a rare one, of leukæmia. The spleen was enlarged from attacks of ague.

Dr. Salzer, because this man had been previously healthy to all appearance, and had never suffered from hemorrhages, supposes the attack to have been due not to extravasation, but to stimulation of the nervi erigentes from anatomical changes in the nerves themselves, or from pressure upon them by enlarged lumbar glands.

Treatment.—Local remedies—such as sedative fomentations, and in some instances ice, cautiously applied—may be tried. The affection appears to run its course, and not to be much influenced by remedies; it seems, therefore, as a rule, undesirable to make incisions into the part, as the injury to the penis is thereby intensified, and the patient's illness rendered more severe; if incisions are made, the resulting wounds must be treated, according to their condition, with poultices, stimulating lotions, strapping, etc. The more modern method of treatment by aspiration or antiseptic incision may afford a better result. We must choose our internal remedies from the sedative class of drugs, employing such articles as lupulin, digitalis, belladonna, bromide of potassium, chloral, nitrite of amyl, and opium; colchicum is useful in some cases; chloroform may be administered as an anæsthetic.

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[1] Berliner klin. Wochensch., No. 11, 1879; Practitioner, vol. i. p. 296. 1880.

INJURIES AND DISEASES OF THE FEMALE GENITALS.

BY

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Modes of Exploration.

Touch and Sight are the chief means in the diagnosis of diseases and injuries of the female organs of generation. The former in most cases precedes, and in some enables a diagnosis to be made without resorting to, the latter; in its most common form, examination by the finger passed into the vagina, it is painless, and is less repulsive to the patient, so that she more readily consents to it than to a visual examination, whether this be made without or with a speculum.

Touch in its widest signification includes not only an internal examination, usually made by the right or left index finger introduced through one of the three openings in the pelvic floor—vagina, rectum, urethra—but also that form of external examination commonly called abdominal palpation, and the different combinations of two or more of these, the most important being abdomino-vaginal, or that which is generally known as bimanual examination. It also embraces the use of the uterine sound or probe, for this instrument has its chief value in rendering parts too remote from, or otherwise inaccessible to, the finger, more or less readily explored, thus giving a mediate instead of immediate touch.

By *sight*, or *inspection*, we learn the condition of the surface of the abdominal wall, that of the external organs of generation, and of adjacent parts, and, if the fingers be used to separate the labia, or, by pressure through the rectum, to evert the vagina—or if the patient be urged to strain, to "bear down"—a part of the vaginal wall is exposed. A speculum is used to bring in view the vagina, especially its upper part, and the vaginal portion of the uterine neck.

Additional means of examination are given by mensuration; abdominal auscultation and percussion; artificial dilatation of the uterine canal; artificial prolapsus of the uterus, effected by seizing the neck of the uterus with a tenaculum or tenaculum-forceps, and then exerting moderate and continuous traction until it is brought near or quite to the vulvar opening; and aspiration of liquid cysts, or exploratory puncture, to determine, by the obvious characters of the fluid thus obtained, or by subsequent microscopic or chemical examination, its true nature. A fragment of a new growth, too, artificially or spontaneously detached, may be submitted to microscopic examination, and in some cases exploratory abdominal incision is necessary.

TABLE FOR EXAMINATION; GENERAL PREPARATIONS; POSITION OF PATIENT. —Many ingenious gynæcological tables and chairs have been invented, and offer certain advantages and conveniences. Nevertheless, an ordinary table of wood, about thirty inches in height, will answer in most cases quite as well as the often expensive and complicated furniture referred to, and will be less likely to frighten a nervous patient. This table is covered with a thick blanket or comforter, folded upon itself, so as make the artificial couch less hard while it remains sufficiently resisting; a sheet is laid over the blanket or comforter, and one or more pillows are provided. Two chairs are necessary, for the patient to rest her feet upon when her hips are brought to the foot of the table, and a sheet is at hand to protect her person from exposure during the examination. If she be examined in bed, this should be of such firm, resisting material that her hips will not sink in it. The bladder and bowels should be empty, and if their evacuation be recent, and just after they have been distended, the resulting relaxation of the abdominal wall greatly facilitates abdominal palpation. An anæsthetic is sometimes necessary, as in cases of hyperæsthesia or of great resistance of the abdominal wall, in certain painful affections of the external organs of generation, in very nervous, sensitive patients, or where dilatation of the passages may be necessary for exploration; it is also recommended in the case of young girls, to protect their modesty from shock. Renal disease, idiosyncrasy, great exhaustion, or fatty disease of the heart may forbid its use. When an anæsthetic is used, of course a third party is necessarily present; and in most cases, especially if the examination be protracted, it is advisable to have one or more persons in the room, prudence and self-protection suggesting this precaution.

It is rare that it is advantageous or advisable to make vaginal touch when the patient is standing, though some displacements of the uterus or of the vagina may be better appreciated if the examination be thus made than if she be recumbent. In making it, the patient stands with her hips against the wall or other firm object, and her body slightly inclined, while the examiner occupies a low seat, or rests one knee upon the floor, directly in front of her; one hand, the index finger being covered with carbolized oil, soap, or something similar, is passed beneath her clothing, and the finger is introduced into the vagina. Vaginal touch is usually made with the patient lying upon her back, the lower limbs moderately flexed, and the head supported by a single pillow. This also is the position taken for external as well as for internal touch, and for conjoined touch, or the bimanual examination. Modifications of the dorsal position are known as the lithotomy and the dorso-sacral position. In the former, the patient's hips are brought to the edge of the table or bed, the legs are flexed on the thighs, the latter are strongly flexed upon the trunk and supported by assistants, and the pelvis is then flexed upon the vertebral column while the head rests upon one pillow; in the latter, the lower limbs are only moderately flexed, but the head and shoulders are raised so that the woman is placed in a position between that of sitting and that of lying.

The abdominal position is that in which the trunk and limbs are extended, so that the former rests upon the abdomen and the thorax; it is used for examination of the vertebral column, the posterior wall of the basin, and the back. There are different modifications of this position, the two extremes being that in which the patient rests upon her knees, the thighs being at right angles to the pelvis, and upon her hands; and that in which, the knees occupying the same position as before, the anterior part of the trunk is supported by the head, or by the upper part of the thorax. In the first of these modifications the plane of the trunk is nearly or quite parallel with that of the examining table, while in the other they make an angle varying from thirty to forty-five degrees. In the latter position, commonly known as the knee-chest or genu-thoracic, the pelvis is much higher than the chest, and intra-abdominal pressure is quite absent, so that it is impossible to evacuate the bladder, though quite full of urine, with a catheter. When the body rests upon the knees and elbows, the position is known as the genu-brachial. The knee-chest[1] position is often of value in facilitating the reduction of posterior displacements of the womb, in setting free this organ in case it has been wedged in the pelvis by a tumor, and in making accessible tumors situated in the back part of the abdominal cavity.

In the *lateral* position the patient lies upon one or the other side, the trunk resting upon the corresponding iliac crest and the shoulder, while a single pillow is placed under the head; if at the same time the thighs are strongly flexed, and the hips brought to the edge of the table or bed, the vulva is brought into view. This position is uncomfortable, and hard for the patient to keep, and is seldom used, except in abdominal palpation and percussion, in determining the mobility of tumors, and in making, by the changing area of dulness and resonance, a diagnosis between, for example, a cystic tumor and ascites; the patient lies alternately upon one and the other side, in such examination. The semiprone, latero-abdominal, or Sims position, is that in which the Sims speculum is most frequently used. The patient may lie upon the right or upon the left side—the latter was preferred by Sims, because an assistant could then hold the speculum with the right hand—the lower arm is placed behind the back so that the upper shoulder is inclined to the table, the thighs and legs are each bent at nearly a right angle, the flexion of the upper being a little more than that of the under thigh so that the corresponding knee rests upon the table. This position in its effects approximates that of the genu-pectoral, and thus the abdominal pressure is very much diminished, becoming less than atmospheric pressure. While this position is by many regarded as superior to any other when the univalve speculum is used, and is important in many operations upon the vagina and the neck of the womb, it is not advisable for the purpose of digital examination.

In all these different positions—abdominal, dorsal, and lateral, and their modifications—it is important that the patient's clothing should be loose, and especially that there should be no constriction of the waist. In all examinations and operations careful antiseptic precautions must be used—hands and instruments must alike be aseptic. Further, the surgeon must be upon his guard against the possibility of becoming infected with syphilis in his professional work; the dire poison may lurk where least suspected, and a slight abrasion, a recent scratch upon his finger, for example, may be an avenue for its entrance.

VAGINAL TOUCH.—Reference has already been made to vaginal touch when the subject is standing. Usually, however, it is done when she is lying, and the position most commonly selected is the dorsal. A single finger, generally the index, is used; the reasons for using only one finger are the facility of introduction—a consideration of some moment if the patient is a virgin—the greater range of movement, and the clearer sensation thus obtained. As to whether the right or left index shall be selected, this will depend, if the patient be in bed, upon the side of the bed which can be approached; if, as is frequently the case, the external touch, or abdominal palpation, is to be used also, most prefer the left index finger for the internal examination; if the left side of the pelvis is to be especially examined, then also the left finger is selected, but if the right side, the right finger.

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[1] Hegar und Kaltenbach, Die operative Gynäkologie, u. s. w.

Previous to the examination the hands are thoroughly washed with warm water and soap—carbolized or tar soap is preferable—after which it is well to bathe them in an antiseptic solution, such as of corrosive sublimate, one part to two thousand; the examining finger is then covered with carbolized cosmoline, oil, soap, or some similar substance; if soap be used, not only should the finger be perfectly covered, but some of the soap should fill the space between the nail and the pulp, so as to exclude the lodgment of offensive or injurious discharges from the genitals, or from the rectum, should the rectal follow the vaginal touch.

The thumb and index finger are extended and stretched apart, while the other fingers are either flexed upon the palm, or half flexed so that they are at a right angle to the index. The hand is now passed under the sheet which covers the patient and her clothing, and is either, according to the practice of many, introduced from above between the thighs which are extended, or, which others prefer, is carried beneath the near limb, both lower limbs being moderately flexed. The advantages of the latter method are the greater freedom of movement, the less constrained position of the hand, and the relaxation of the abdominal wall that is secured by flexion of the limbs—the last being essential for the abdominal examination which often follows or is associated with the vaginal. The finger should be passed from the perineum to the vulvar opening; before entering the latter, the condition of the external parts as to sensibility, swelling, secretion, and temperature, may be noted; if the hymen be present, the thighs ought to be brought near each other, and the greatest gentleness used so as to prevent its rupture. After the finger has been passed a short distance within the vagina, the perineum should, as advised by Emmet, "be gently but firmly depressed for the admission of air, which will open the passage and give sufficient space for examination;" the surgeon then turns "the palm of the hand uppermost, so that the curve of the finger will correspond to that of the vagina." The condition of the vagina as to form, size, temperature, secretion, and sensibility, and as to the presence of fistulæ, cicatrices, or new growths, is ascertained; the position of the uterine neck, normally in a line connecting the ischial spines, is learned, and also its size, form, and length; next the external os is examined as to form and size, and also as to the condition of its lips. The weight and the mobility of the uterus are determined, and the state of the vaginal cul-de-sacs as to depth and size. The elbow being made to sink in the bed, the finger as far as possible examines the anterior, the posterior, and the lateral walls of the womb, ascertaining thus the sensibility, shape, and consistence of the organ. Upon withdrawing the finger, the secretion adhering to it will be observed as to appearance and odor.

Rectal Touch.—If this be necessary, it may be made immediately after vaginal touch, and is done without acquainting the patient with the purpose. She still lies upon her back, and the finger, directed to the anus, gently overcomes the resistance of the sphincter, and is directed backward and upward. The neck of the womb is felt when the finger has advanced about an inch from the anal opening; passing it still farther, a part of the posterior wall of the uterus and of its sides may be felt, as well as the utero-sacral ligaments, but the fundus cannot be reached unless the organ be retroverted or retroflexed. In those rare cases in which it may be considered justifiable or necessary to pass the entire hand into the rectum, as first practised by Simon, the patient must be anæsthetized. Two fingers are first introduced, and the anal orifice dilated until three, then four, and finally five, in the form of a cone, can enter. This method of exploration ought, according to L. de Sinéty, to be reserved for entirely exceptional cases; although, having had occasion to use it, he has been surprised at the little injury done. Rectal touch is rarely employed alone.

VESICAL TOUCH.—Dilatation of the urethra precedes this method of examination; the dilatation may be rapid or gradual. In rapid dilatation an anæsthetic must be used; the means used for dilating may be simply the little finger, some one of the uterine dilators, such as Ellinger's, or a polypus forceps; Noeggerath advises a Holt's stricture-dilator, followed by Busch's. In any case, a little nick on each side of the meatus facilitates the dilatation.

The means by which slow dilatation is best effected is a series of graduated steel or hard-rubber bougies, the dilatation being continued from day to day, or at intervals of two or three days, until the canal admits the index finger; dilatation by tents is to be rejected. After dilatation and examination of the bladder, a disinfectant solution should be used to wash out the organ, in order to guard against septic inflammation; a solution of carbolic acid or of the corrosive chloride is suitable.

Urethral dilatation is used for the discovery of disease of the bladder, of tumors, of foreign bodies, and of calculi, and in the diagnosis of uterine inversion if this be obscure, "of absence of the vesico-vaginal wall, if there be atresia of the vagina, and of the opening of a fistulous track into the bladder" (Hegar). Dr. Emmet believes that the risk of urinary incontinence from urethral dilatation is too great to be compensated for by any advantages of this means of diagnosis.

EXTERNAL TOUCH OR ABDOMINAL PALPATION.—The patient lies upon her back, the upper limbs extended by the sides of the trunk, the lower limbs more or less flexed, and the head supported by one pillow. The abdomen is uncovered, although, according to Tarnier, a fine, soft chemise does not prevent clear sensations in palpating. The palmar surfaces of the hands are first applied with moderate pressure to different parts of the abdominal wall, accustoming it to contact, and thus preventing muscular resistance. If there be marked hyperæsthesia, care must be taken to ascertain whether this be nervous in its origin, or if it arise from inflammation; in the former case, light pressure is less tolerated than strong; and in the latter, the examination must be made most gently, or postponed; very great nervous sensibility, or excessive tension of the abdominal wall, may require the use of an anæsthetic, though the difficulty caused by excessive tension may in some cases be overcome by having the patient make frequent and deep inspirations, when, immediately after an expiration, the hand readily depresses the hitherto resisting abdominal wall. The condition of the wall as to thickness and consistence will be noted, as well as the symmetry of the two sides; each inguinal region is examined as to the possible presence of a hernia, or of enlarged lymphatic glands. If a tumor be discovered, it is examined as to position, sensibility, form, size, consistence, and adherence to adjacent parts, the latter being learned by its mobility, and "by insinuating the fingers between it and neighboring organs" (Hegar). A superficial tumor may in some cases be grasped by the two hands or by one hand, while a deep-seated tumor, as, for example, one situated in the lumbar region, may be explored by a hand placed at the level of the kidneys and pressing from behind forwards, while the other hand is placed opposite, upon the abdominal wall, pressing from before backwards, the tumor being thus included between the hands (Hegar and Kaltenbach).

Ballottement usually results from a movement impressed upon a solid body floating in a liquid, and has been compared by Pajot to the movement given a piece of ice floating in a glass of water by a quick tap with the finger; the movement is double—first, the receding of the ice, and then its return so that it strikes the finger left in the position it was in after moving the ice. Abdominal ballottement is a valuable sign of pregnancy, and yet, in a case mentioned by Pajot, it was observed in cystic ovarian disease. Cazeaux recommended, in the diagnosis of early pregnancy, having the woman lie upon her side; the hand of the examiner, placed between the side and the bed, recognizes fœtal parts which may be readily displaced, and which quickly return to the place previously occupied. The late Dr. Albert H. Smith not only placed the patient upon her side, but also had the abdominal wall project over the edge of the bed, and indeed be made somewhat dependent; one hand of the examiner was placed beneath the projecting abdomen and supported it, while the other made counter-pressure upon the opposite side; ballottement can thus, in case of pregnancy, be satisfactorily recognized.

A diagnostic mark of fluid collected in tissues or in a cavity, is fluctuation, a term, however, which includes two analogous but different sensations, only one of which may be present. Thus in cystic disease of the ovary or of the broad ligament, if the tumor be large, a very distinct wave may be felt with one hand applied by its palmar surface to one side of the enlargement, while a quick tap is given the opposite side with the fingers of the other hand; and again, when the pulp of the index finger of each hand is placed upon a tumor, and then one finger is depressed while the other remains fixed, or when the fingers are alternately depressed and raised, a sensation of displaced fluid is recognized. In either case, fluctuation is said to be present. If, however, the tumor be deep seated, or have very thick walls, the recognition of fluctuation is difficult; and, on the other hand, solid tumors that are œdematous, or that have undergone fatty degeneration, may give what is called false fluctuation.

COMBINED EXAMINATION.—(1) Abdomino-vaginal; (2) Abdomino-rectal; (3) Vesico-vaginal; (4) Vesico-rectal; (5) Vagino-rectal; and (6) Abdomino-uterine. The first two are the most important.

Abdomino-vaginal Examination.—By this one learns "the position, volume, and form of the uterus, the relations of this organ with its appendages, especially with the ovaries, and finally the character of tumors seated in the pelvis."[1] The position of the patient is that in which vaginal touch is usually practised. In making the examination as it relates to the uterus, the index finger of one hand is passed into the vagina so as to touch the os uteri, while the other hand is placed upon the abdomen, and the fingers directed at first towards the lumbar vertebræ, and then downward to the inlet, so as to press upon the uterus. This organ is known to be included between the external hand and the internal finger, by the fact that a movement given the solid mass by one is felt by the other. By increasing the pressure of the external hand from behind forward, the uterus may be more or less anteflexed or anteverted; a reverse movement may cause retroversion. If the finger be placed in the anterior cul-de-sac, while the hand presses the uterus forward and downward, the thickness and sensibility of the organ may be estimated; the same end is attained by placing the finger in the posterior *cul-de-sac* while the organ is pressed downward and backward.

Tumors or effusions in the anterior or in the posterior *cul-de-sac*, infiltrations of the vesico-vaginal wall, or of the connective tissue joining the bladder and the neck of the uterus, and foreign bodies in the bladder, may be recognized by abdomino-vaginal examination. If the hand and finger be placed upon the sides of the uterus, and the former press the organs and tissues between the two downward and forward toward the latter, tumors may be felt, as also the round ligaments, and, if the uterus be anteverted or anteflexed, the ovary; Sir James Simpson advised, in examining the latter, not only to antevert the uterus, but also to turn it by the uterine sound toward the opposite side, so as to stretch the broad ligament of the side examined. In most cases the examination of the ovaries is made better by the abdomino-rectal than by the abdomino-vaginal method. If a tumor be discovered, its form, size, and consistence, and its connections with adjacent parts are to be learned. In examining the right side of the pelvis one or two fingers of the right hand will be introduced into the vagina, and one or two of the left hand for examining the left side.

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[1] Hegar und Kaltenbach, op. cit.

Abdomino-rectal Examination.—In this examination usually two fingers are introduced into the rectum, and then, the external hand pressing the uterus backwards and downwards, the fundus is reached, and the entire outline of the organ can be followed.[1] The utero-sacral ligaments can be examined, as well as the broad ligaments, external pressure being used to bring them nearer the fingers. So too, by means of this pressure, the ovarian ligament and the ovary can be felt. Enlargement of the oviducts, and small tumors of the ovary or of the broad ligaments, can be, as a rule, more easily recognized by this than by abdomino-vaginal examination. This method is important in cases of absence or imperfect development of the uterus, or absence of the ovaries, as well as in determining the presence of pathological swellings or growths.

Vesico-vaginal and *vesico-rectal* touch have been urged by Noeggerath for, among other purposes, the diagnosis of obscure tumors of or near the uterus, to complete the diagnosis of uterine inversion, and for the diagnosis of congenital absence or malformation of the uterus. *Recto-vaginal* touch is made with the index finger in one, and the thumb in the other canal; or the index of each hand may be used, one finger being passed into the rectum and the other into the vagina.

Opportunity for *abdomino-uterine* examination is rarely offered, but Hegar and Kaltenbach advise that, if the neck of the womb will admit the finger, or if it have been dilated for some other pupose, an examination should be made by the finger passed into the uterine cavity, combined with abdominal palpation. In posterior displacements of the womb, if adhesions prevent reposition, Schultze performs what he has termed intra-uterine reposition, as well for the recognition as for the removal of the obstacles; the finger of one hand is introduced into the previously dilated uterus, while those of the other are applied to the abdominal wall relaxed by anæsthesia.

MEDIATE TOUCH, OR EXAMINATION WITH THE UTERINE SOUND OR PROBE.—The *uterine sound*, also called a *redresseur* or *hysterometer*, according to the special use made of it, is a metallic rod, curved and graduated, having a somewhat bulb-like enlargement at its uterine end, and a knob two inches and a half from this; it may be rigid or flexible. The *uterine probe* is usually made of virgin silver or of plated flexible copper, though it may be of hard rubber or of whalebone, is about the thickness of the probe found in the surgeon's dressing-case, and is quite flexible. The flexibility of the latter instrument facilitates its introduction into a tortuous cervical canal, or an irregularly enlarged uterine cavity; on the other hand, a larger instrument is less liable to be arrested by catching in folds of mucous membrane.

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[1] Hegar und Kaltenbach, op. cit.

The uterine sound is used to learn the permeability of the cervical canal, its direction, length, and size, and the absence of abnormal narrowing at any point, with the length, size, and direction of the uterine cavity; it also detects excessive sensibility, or hyperæmia of the lining membrane of the uterus, the presence of local hypertrophies or of new growths, and the mobility of the organ.

The sound is usually introduced without the speculum. If there be much vaginal discharge, especially if it be offensive, it should be washed away by an antiseptic injection before using the sound, lest the latter should convey some of it to the uterine cavity, and septicæmia result, an accident which has thus happened. The patient occupying the dorsal position, with her lower limbs more or less flexed upon the trunk, the index finger of one hand is passed into the vagina and placed upon the posterior lip just below the external os uteri, and the beak of the sound, first dipped in an antiseptic solution, or coated with an antiseptic ointment, is thus guided into the cervical canal; if a speculum is used, it is well to withdraw it after the beak of the sound has entered the os uteri. Usually the concave surface of the sound is above at the moment of introduction, but in some cases it is easier to penetrate the canal by having this concavity below, and, after passing the instrument three-fourths of an inch, then giving it a rotation so as to place this surface uppermost. The sound is usually introduced when the patient is lying upon her back, but it may also be used if she be upon one or the other side.

The uterine probe is best used when the os is exposed by means of a Simon's or Sims's speculum; after such exposure a tenaculum is used to catch the cervix, thus steadying the organ and somewhat straightening the cervical canal, and the probe, having been previously given such curve as digital or bimanual examination may have indicated, is then introduced.

Accidents resulting from the use of the uterine sound have not been infrequent. Broca, in 1854, first mentioned a death from this cause, and since then numbers of cases, published and unpublished, have occurred, in which more or less serious consequences have followed the use of this instrument.[1] Many instances are recorded in which the sound has penetrated the wall of the uterus, either by perforating it, or by entering a metro-peritoneal fistula; in rare cases the sound has entered one of the oviducts, but of course there must have been unnatural patency of the duct, and, as remarked by Thorburn, this charitable explanation will rarely suffice. The possible presence of pregnancy, and the existence of acute inflammatory affections of the uterus, are absolute contra-indications to the use of either the sound or probe.

The sound is much less frequently used than it formerly was. Hegar and Kaltenbach remark that most of the information sought by the sound, can be equally obtained by other methods; Scanzoni holds that the expert seldom needs it; Schultze says that he who has acquired a certain dexterity in bimanual exploration, has rarely need of the uterine sound in order to know the situation of the uterus; and Tait thinks that it is an unnecessary instrument.

Schultze recommends that the use of a sound in the uterus, and also of one in the bladder, should be combined with recto-abdominal examination and with abdominal palpation, in certain cases in which tumors fill the pelvis and the space above, and in which palpation alone does not enable the surgeon to say whether the tumors which are at the side of the uterus and displace it belong to that part itself or to neighboring organs. Thus two fingers of one hand are passed very high in the rectum, and the thumb is placed in the vagina, while the other hand is applied to the abdominal wall; one sound is introduced into the womb and another into the bladder, one of them being held by an aid, while the surgeon explores with the other, using each successively and alternately; this quadruple or quintuple examination may make an otherwise obscure case clear.

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[1] Chrobak.

Visual Examination.—This may be immediate or mediate, that is, made by direct inspection, or through a speculum. In the direct examination the surgeon notes the general appearance of the patient, her form, movements, and facial expression, and the presence or absence of pigmentation upon the forehead and cheeks; the condition of the mammary glands as to size, secretion, enlargement of the glands of Montgomery, and formation of primary and secondary areolæ; the state of the abdominal wall, enlargement of veins, *lineæ albicantes*, pigment deposit over the median line, irregularity or symmetry of form, increase of prominence, sinking or protrusion of the umbilicus, and existence of fœtal movements. Attention, however, will be directed more especially to the external genital organs and adjacent parts. For this examination the patient should occupy the dorsal position, with the lower limbs strongly flexed upon the trunk, and the thighs separated. The condition of the groins is observed as to whether enlarged lymphatics, or cicatrices, are present; that of the anus, as to prolapsus, external hemorrhoids, or condylomata; that of the perineum and mons veneris; that of the labia, if œdematous, varicose, or inflamed, or the seat of tumors. When the labia are separated by two fingers, the vestibule, with the orifice of the urethra, which may be the seat of the so-called sensitive tumor of the meatus, and the clitoris, will be exposed, and so too the navicular fossa, and the hymen or the myrtiform caruncles. Eversion of a part of the vagina may be effected, as first suggested by Dr. H. R. Storer, by two fingers pressing through the rectum upon the recto-vaginal wall; but this is rarely necessary, and it is usually quite painful.

Examination with the Speculum.—An examination of the deeper part of the vagina, and of the uterine neck, if in normal position, can be made only with instruments known as uterine specula. While very many different specula have been invented, only three varieties will be here mentioned, viz., the tubular or cylindrical, the bivalve, and the univalve.

The *tubular* speculum most frequently used is known as Fergusson's. This instrument is a glass tube, silvered and covered with rubber varnish. The instrument is usually narrower at the internal end, and obliquely cut, while the external part is expanded somewhat like the mouth of a trumpet—an unnecessary form, which renders it less portable and more liable to be broken; a cylinder of uniform diameter is preferable. Besides, the reflection from its mirror-like construction sometimes confuses—makes "dark with excess of light"—and in this regard the opaque glass speculum of Mayor has a decided advantage. In addition to glass tubular specula, there are others made of wood, of ivory, of hard rubber, of metal, and recently of celluloid.

The tubular speculum is very little used in this country for diagnostic purposes, for it often conceals more than it reveals; it has the advantage that one can employ it without an assistant. A previous digital examination having made known the capacity of the vagina, an instrument of suitable size is selected, and, after being warmed and oiled, is introduced by first separating the labia and directing the instrument in the vulvar axis, the patient occupying the lithotomy position. After the instrument has entered the vagina, its further course is guided by the position which the digital examination has shown to be occupied by the mouth of the womb, and the instrument is, if necessary, rotated so that the most projecting part shall come behind the cervix.

The *bivalve* speculum most frequently used is that of Cusco, or some modification of it. The blades are united by a joint, and after the instrument is introduced, they are placed so that one is in relation with the anterior, the other with the posterior vaginal wall, and then, by means of a screw placed externally, they are separated; this is a self-retaining instrument. In Goodell's speculum the blades are separated laterally with reference to the vagina. Neugebauer's is one of the most useful of bivalve specula. It consists of four blades of different sizes in a set, thus permitting the formation of three specula; there are no fixed screws or joints to rust, or otherwise get out of order, and the instrument may be much more readily cleaned than Cusco's, or any of its modifications; by uniting with the accompanying screw the external part of two of the blades, a substitute for a Sims's speculum, which may answer for an emergency, is formed; it is, if the patient makes no straining efforts, self-retaining, or at least requires the examiner to hold only the upper blade in position.

The Cusco or the Neugebauer speculum is generally used with the patient in the lithotomy position. In using the latter instrument, the blades having been properly prepared, the larger is introduced with its convex surface in relation to the posterior vaginal wall, when the smaller has its beak dipping in between the sides of the other blade, and of course its convex surface in relation to the anterior vaginal wall. The lower blade has its beak behind, the upper, above the vaginal cervix; by separating the handles the cervix is exposed, and a certain amount of traction may also be made by this separation so that the uterus is drawn down; either arm of this bivalve speculum can be readily lengthened or shortened as the examination may require.

The most useful of uterine specula is the *univalve* instrument of Sims, or the same as modified by Simon. The Sims speculum is composed of two blades differing in size, united by a handle, or shank, the blades being at right angles to the shank. The blades are concavo-convex; the instrument is usually made of silver-plated metal, but sometimes of hard rubber. This speculum may be used with the patient in the genu-pectoral, or in the abdomino-lateral position; the latter position is less trying to her, and usually the more convenient for examination and operation. It is advisable to have two of these specula, and thus four blades of different sizes. The surgeon selects a blade of suitable size for the case, and, after warming and oiling it, holds it in one hand, while the other separates the labia for its entrance; the index finger is now placed in the concavity of the blade, its point projecting a little beyond the end of the latter, and is used as a guide until the blade reaches the upper part of the posterior portion of the vagina. After the introduction of this blade the instrument is firmly grasped by the shank, near the other, and the perineum is drawn back, for the instrument acts chiefly as a perineal retractor. The anterior vaginal wall may hide the cervix from view, and then an instrument devised by Dr. Sims, called a *depressor*, is necessary with which to push it away; this is made of plated copper, and is composed of a rod formed at one end into a fenestrated oval or circular, while a wooden handle is attached to the other. Tenaculum or tenaculum-forceps may also be necessary for perfect exposure of the cervix, as well as to fix it for further examination, or for making applications.

The speculum of Simon is composed of four blades of different sizes, with a handle to which any of the blades may be fastened at a right angle; the blades have about the same form as those of the Sims speculum, though presenting some advantages, and the instrument may be used in all cases to which that is adapted, while it is less fatiguing to the person holding it, because of the form of the handle. There are also four metallic plates, differing in size, and a handle to which any one of these may be fastened, and by this means the anterior vaginal wall is lifted out of the way. The patient usually occupies the dorso-sacral position when the Simon speculum is used; one assistant holds the speculum, drawing the posterior vaginal wall and perineum downward, while another assistant draws upon the handle to which one of the plates has been fastened, this being placed upon the anterior vaginal wall. In some cases it is necessary to use retractors also for the lateral walls of the vagina, and then two more assistants are required, one for each side. Undoubtedly, when examinations are made in the dorso-sacral position, Simon's instruments are invaluable, and so too they prove very useful in operations for genito-urinary fistulæ.

Mensuration.—This is effected with the patient lying down, and an ordinary tape-measure may be used; the bowels and bladder should have been recently emptied. By mensuration we learn the rate of increase of an abdominal growth, as well as its size; and whether it is situated in the upper or lower part of the abdominal cavity, or in one or the other side. The measurements usually taken are the circumference at the umbilicus, the distance from the latter to the ensiform cartilage, to the pubic symphysis and to the anterior superior spinous processes of the ilium on each side, and from these points to the ensiform cartilage. In the differential diagnosis of ascites and cystic disease of the ovary, it is to be noted that the abdominal circumference is in the former affection greatest at the umbilicus, while in the latter it is in most cases greatest at a somewhat lower point.

Auscultation.—The abdomen should be uncovered, and the patient should ccupy the dorsal position when auscultation is practised; on many accounts it is better to use a stethoscope than to apply the ear directly to the abdomen. The value of auscultation in determining the presence of pregnancy, by distinct recognition of the sounds of the fœtal heart, cannot be over-estimated, whether the abdominal enlargement is due solely to this condition, or whether it is only a complication. The sound of next importance heard in auscultating the abdomen of a pregnant woman, is the uterine souffle. But this souffle may be heard when the uterus is enlarged from other causes, though not in all instances; thus in uterine tumors it is heard in half the cases, furnishing a probability in favor of a tumor being uterine rather than ovarian. A similar souffle has been heard exceptionally in some cases of ovarian tumor, in a retro-uterine tumor (Winckel), in tumors of the spleen (Winckel, Virchow, Hirschfeld), and in cancer of the liver (Leopold). Friction sounds caused by the movements of the roughened peritoneal surface may in some cases be heard; in some, as, for example, where an ovarian tumor is of great size and where inflammation of the peritoneum has occurred, crepitus may be detected by palpation; this may also result from the presence of papillary excrescences. Metallic tinkling has, according to Schroeder, been heard where there has been a pelvic exudation communicating with the intestine, and in ovarian tumors in which a formation of gas has occurred.

In diagnosing between cystic ovarian disease and ascites, it is to be remembered that the aortic sound and impulse are transmitted by the former, but not by the latter.

Percussion.—This is usually practised with the patient in the dorsal position, though it is often necessary to make her turn to one and then to the other side, observing the changes in the percussion sound in these varying postures. Percussion does not enable the surgeon to distinguish between a uterine and an ovarian tumor, but it does between either of these and ascites. So too, it prevents confounding a tympanitic abdomen with one distended by ascitic fluid or by a new growth; it enables the surgeon to "map out" the position of a tumor, to determine in some measure its relations with adjacent parts, and to recognize a coil of intestine lying between it and the abdominal wall; it prevents mistaking physometra for hæmatometra.

Dilatation of the Cervical Canal.—This may be indicated for the direct examination of the uterine cavity with the finger, or with the curette or curette-forceps, or for the removal of an intra-uterine growth. The means for dilating are the different tents, made of sponge, sea-tangle, gentian, or tupelo; or a series of solid metal or hard-rubber dilators, or metal dilators composed of two or more blades, which are introduced closed and then separated from each other; Ellinger's, and its various imitations and modifications, have two blades, Sims's has three, as has Scanzoni's, and quite recently Molesworth has devised an ingenious dilator with four blades. Tupelo tents are generally preferred to others; some fatal results from those of sponge suggest hesitancy in resorting to them, and great caution in their use. Antiseptic precautions must be used, no matter what the dilating means, but especially in the employment of tents.

The os uteri, if a tent is to be introduced, is exposed by a Simon or Sims speculum, the cervix is caught by a tenaculum, and the tent—one of appropriate size and form having been provided, and an antiseptic having been first put upon its external surface—is carried by the forceps or by a stylet devised for the purpose, into the os, and is pressed into the cervical canal. If the tent be of sponge, simply holding it in place for a few minutes will secure its retention; but if it be of tupelo or of sea-tangle, a cotton tampon must be placed in the vagina and pressed against the os to prevent its expulsion. A sponge tent is completely expanded in a few hours, while a sea-tangle tent requires fifteen or twenty hours. If the dilatation is insufficient for exploratory or operative purposes, the first tent is removed, and, after thoroughly cleansing the surfaces with which it has been in contact with an antiseptic solution, a larger one is put in its place; but the immediate repetition of these dilating means is if possible to be avoided.

If the dilatation is sufficient for the introduction of the finger, this is done as follows: The patient occupies the dorsal position, and has her lower limbs moderately flexed; the surgeon places one of his hands upon her abdomen, over the fundus of the uterus, while the index finger of the other hand passes into the vagina, and then into the os uteri, and now the external hand presses the uterus down upon the internal finger—the method being compared to pressing a thimble upon the finger—until the uterine cavity is entered, when the desired examination is made. Dr. Emmet advises washing out the uterus with warm water after the examination, and the application of Churchill's tincture of iodine, which not only is an excellent disinfectant but also stimulates uterine contraction.

Hegar rejects dilatation both by tents and by Ellinger's or similar instruments, his objection to the latter being that they dilate unequally, affecting only those parts of the cervix with which the blades are in contact; he uses hard-rubber dilators, cylindrical in general form, and conical at the end for more ready introduction into the cervical canal. Before using them they are placed in a five-per-cent. solution of carbolic acid, and just previous to their introduction they are dipped in five-per-cent. or ten-per-cent. carbolized oil. The first dilator is replaced by a larger one in a short time, this varying with the resistance met; usually only an hour, often less than this, is required to effect sufficient dilatation for the introduction of the finger.

Of course, dilatation is forbidden by inflammation of the uterus or of adjacent structures. The patient should lie in bed during the process, and there remain for a day after it and the following examination.

The curette, or Emmet's *curette-forceps*, may be used to remove fragments of an intra-uterine growth, and its general appearance, or a microscopic examination, will determine its true nature.

The Exploring Needle.—This may be used to ascertain whether a tumor is fluid or solid, and, if the former, the nature of the fluid, whether purulent, sanguineous, serous, etc.

The diagnosis of abdominal tumors, uterine, ovarian, or other, by chemical or microscopic examination, is treated of elsewhere.

Examination by the microscope of vaginal or of uterine discharges may be in some cases of great value, as, for example, in determining by the presence or absence of the gonococcus, the nature of a vaginal or uterine inflammation.

Ruptures and Wounds of the Vagina.

Ruptures of the vagina occur almost exclusively in child-birth, and they are then either spontaneous or traumatic; the traumatism is usually done by the hand or by the obstetric forceps, but it may happen in the extraction of fragments of the fœtal bones.

Spontaneous rupture in the upper part of the vagina is frequently associated with rupture of the uterus, involving the same accidents and symptoms, and requiring the same treatment, while that of the lower or middle part generally arises from stenosis of the canal. In spontaneous ruptures of the upper portion of the vagina, the injury may involve[1] more than half the vaginal circumference, and in one[2] instance, where simple traction upon the cord was followed by the extraction of the uterus, the placenta being still within it, the probability is that the uterus was by spontaneous rupture of the vagina so nearly separated from its vaginal attachment that only a slight force was needed to make the separation complete.

Fehling[3] has recorded a remarkable instance of rupture of the vagina occurring in a woman 63 years old. The subject had suffered from vaginal prolapsus for several years, and this having been increased by severe exertion, she endeavored with her fingers to push back the protruding parts, was suddenly conscious of something having given way in her body, and found intestines protruding from the vagina. She died in eleven hours, and the autopsy revealed a transverse rent, six and a half centimetres long, in the posterior vaginal vault.

Thirial[4] has narrated a case where two *sages-femmes*, endeavoring to dilate the vagina of a woman in labor, had torn the vesico-vaginal wall and the urethra so that the entire hand could be introduced into the bladder.

The vagina has been torn in coition, and, according to Diemerbroeck[5] and Dugès,[6] each of whom has reported an example, the tear may be followed by a fatal hemorrhage. Serious rents occurring in connection with this act have been attributed to manipulation[1] rather than to the act itself. Nevertheless, in the light of recently reported cases,[2] it is highly probable that a fatal result may follow a vaginal tear caused in coition. Plazzoni[3] and Sir Spencer Wells[4] have each met with a case where the recto-vaginal wall was torn in the consummation of marriage. More or less serious wounds of the vagina have been caused by fragments of a glass syringe or pessary.

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[1] Collins's Midwifery; Trans. Obstet. Soc. Lond., vol. xx.

[2] Lancet, vol. i., 1869.

[3] Arch. f. Gynäkologie, 1873.

[4] Bibliothèque du Médecin-Praticien, Art. Plaies et ruptures du vagin.

[5] Anatom. lib. i.

[6] Dict. de Méd. et de Chirurg. Prat.

Other wounds of the vagina have resulted from the horn of one of the domestic animals; from sitting down upon, or falling on, a foreign body; or from jumping so that a foreign body, as, for instance, a pencil, the handle of the cover[5] of a privy seat, the handle of a pitchfork,[6] brush,[7] or shovel,[8] a splinter of wood,[9] or a tobacco stick,[10] has penetrated the vagina directly, or has first entered the rectum and then perforated the recto-vaginal wall.

At least two most remarkable instances of recovery after the entrance of the handle of a hay fork through the vagina into the abdominal cavity, have been recorded. The first case was that of an Irish woman who jumped from a corn-rick, and alighted upon the thick end of a hay fork which entered two feet. She recovered, and died four years and a half after the accident, meantime having become pregnant twice, giving birth to a living child from the first pregnancy, but dying during labor at the end of the second. This case was reported by Freer to the Medical Society of London, in 1876. The other case was reported by Dr. James, of Whitesboro, N. Y., to the Boston Gynæcological Society, in 1870. A woman, twenty-seven years of age, in jumping from a hay-mow upon a pile of hay on the barn floor, slid from the hay, and the handle of a pitch-fork entered the vagina, perforating it a little to the right of the median line, between the neck of the womb and the rectum; it passed obliquely into the abdominal cavity till it struck the ninth or tenth rib, near the spinal column upon the left side of the body. She removed the fork, and with great difficulty succeeded in walking to her house; she recovered in four months.

The immediate dangers from these injuries of the vagina are shock, hemorrhage, and septicæmia; the remote dangers are genito-urinary or recto-vaginal fistulæ, vaginal cicatrices or stenosis, and intra-pelvic adhesions causing permanent displacements of the uterus. Omitting the special treatment needed in ruptures of the vagina occurring in labor, the first indication is removal of the foreign body, if one be present, and thorough cleansing of the wound with an antiseptic solution. Shock is to be treated as when it occurs from other injuries. Hemorrhage is usually controlled by the tampon, either with or without the application of cold or astringents; but immediate closure of the wound by means of the continuous catgut suture, would, unless abdominal drainage were necessary, be more efficient, and would secure earlier healing.

Wounds of the Pregnant Uterus.

Wounds of the pregnant uterus may be conveniently divided into vaginal and abdominal. *Vaginal wounds* occur most frequently in criminal abortion; a pointed instrument, for example, is used to puncture the membranes, and, guided, it may be, by a brutal, trembling, or ignorant hand, it wounds the uterus as well as, or instead of, the ovum. Such injuries are of the neck more frequently than of the body of the uterus; in some cases the fœtus has been wounded by the instrument, while in others this has penetrated the uterine wall, and has entered adjacent tissues or organs. The intestines[1] have been thus injured, and Tardieu[2] mentions an instance in which the internal iliac artery was opened, the consequence being a rapidly fatal hemorrhage. Even if the instrument used be blunt, as a uterine sound, the force employed, or the condition of the uterine wall, may be such that the latter is perforated. In a case[3] reported to the Medical Society of Lyons, a woman used a female catheter, introducing it into the womb for the purpose of causing abortion; she succeeded, but the catheter remained, and four months afterward a swelling was observed at the umbilicus, caused by the point of the instrument; an unsuccessful attempt was made to remove this through the uterus, after incising the cervix, and then the abdomen was opened.

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[1] Billroth's Handbuch der Frauenkrankheiten; Real-Encyklopädie der gesammten Heilkunde.

[2] Centralblatt f. Gynäkol., Februar, 1885; Indian Medical Gazette, 1872.

[3] De Part. Generat., lib. ii.

[4] Med. Times and Gazette, 1860.

[5] Lancet, 1855.

[6] American Journal of the Medical Sciences, 1853; Journal of the Gynæcological Society of Boston, 1870; Schmidt's Jahrbücher, 1869; Lancet, 1876.

[7] Transactions of New York Medical Society, 1864.

[8] Centralblatt f. Chirurgie, 1875.

[9] Chicago Medical Examiner, 1873.

[10] American Journal of the Medical Sciences, 1853.

In most cases, vaginal wounds of the pregnant uterus are made known by a post-mortem examination. If discovered while the subject is living, the treatment is, first, to remove the instrument with which the wound has been inflicted, if it be still present, and, second, to subdue the inflammation which follows the injury.

Abdominal wounds of the pregnant uterus have been caused by falls upon stakes, or other pointed objects, by injuries from firearms, from knives or trocars, either before or after incision of the abdominal wall, or from the horns of bulls, steers, or cows.

Reichard[4] has reported the case of an inn-keeper's wife who, near the end of her pregnancy, was shot by a drunken man; the weapon used was a pistol loaded with shot; labor occurred the next day, and the child, which was living, had upon the right clavicle a wound from which a grain of shot with a fragment of the mother's chemise was extracted; the woman recovered. Staples[5] records the case of a woman twenty-eight years old, and also near the end of pregnancy, whose uterus was wounded by a pistol-ball; labor came on in forty hours, and she was delivered of a dead child in whose abdomen the ball was found; she recovered. Hays[6] records the case of a colored girl, eighteen years old and six months pregnant, who was accidentally shot by a pistol, the ball passing through the abdominal wall and wounding both uterus and fœtus; miscarriage took place the next day; the girl recovered. In a case reported by Finnell,[7] where a pregnant woman was stabbed in the abdomen and the fœtus had an incised wound of the thigh, labor did not occur until a week after the injury.

Some cases[8] have occurred in which the wound of the abdominal wall and uterus made by the horn of an animal, has been so large that the fœtus has at once escaped through it, and yet recovery has occurred. Duparcque held[9] that the more extensive was the wound, the more were the tissues relieved of engorgement, and the less intense was the traumatic fever.

The pregnant uterus has been punctured for supposed ascites and for cystic collections of fluid. Illustrations[10] of this error have been published by Blundell, Tavignot, Duncan,[11] and Stickney.[12] In the case reported by Tavignot the woman was eight months pregnant, labor quickly occurred, and the mother died in three days. In that given by Duncan, in which a medical friend, thinking that the patient had ovarian dropsy, performed paracentesis and drew off a large quantity of liquor amnii, desisting only when he recognized the movements of the fœtus striking against the canula, the pregnancy lasted about a month after the operation, and neither mother nor child was injured. Examples of punctured and of incised wounds of the pregnant uterus inflicted after the abdomen has been opened, the uterus being mistaken for an ovarian cyst, are not rare.

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[1] Virginia Medical and Surgical Journal, p. 257. 1858.

[2] Étude Médico-légale sur l'Avortement.

[3] British Medical Journal, 1871.

[4] Bibliothèque du Médecin-Praticien.

[5] Medical Record, 1876.

[6] New Orleans Medical and Surgical Journal, 1879.

[7] See paper by Dr. C. C Lee (Transactions of American Gynæcological Society, vol. viii.).

[8] An example is given by Deneux (Essai sur les Ruptures de la Matrice).

[9] Maladies de la Matrice, tome ii.

[10] Gallez, Historie des Kystes de l'Ovaire.

[11] Mechanism of Natural and Morbid Parturition.

[12] Boston Medical and Surgical Journal, 1876. In the case which Dr. Stickney has reported, the uterus had been tapped twice by another physician, a quart having been drawn off at one time and a pint at another; a third tapping was prevented by the woman falling in labor at the time set for the operation.

Incised or lacerated wounds of the pregnant uterus are best treated by a completion of the Cæsarean operation which the injury has already begun; in some cases, where the uterus has been torn to a great extent, and where the wound is irregular and hæmostasis difficult, the removal of the organ would furnish a better chance of recovery. In punctured wounds of the uterus, as from a trocar, the rule of practice varies according as the uterus has been immediately penetrated, or mediately, that is, through the abdominal wall. In the latter case, the fœtus should not be interfered with. In the former, Dr. Lee[1] holds that, if the ovum be uninjured—and he gives the same advice even in case of an incised wound—the wound should be carefully closed with carbolized sutures, but that if the ovum be injured the Cæsarean operation should be done. While thus far statistics sustain the propriety of the latter course, these are not yet sufficiently numerous to make it an absolute rule; the practice advised in the former condition will be readily accepted by most surgeons, though some, Dr. Byford[1] for example, maintain that the Cæsarean operation is indicated if the pregnancy be advanced.

LACERATIONS OF THE CERVIX UTERI; TRACHELOPLASTY.

The vaginal portion of the neck of the womb is, in the virgin, cone-shaped, its lower portion presenting a round, thick, broad rim, or cushion, with a slight depression in the centre, the external mouth of the womb. There is no division in the circle surrounding the os, no separation into anterior and posterior lips; this distinction is not established until childbirth occurs. The expulsion of the child from the womb causes more or less tearing of the os, the most common and marked of these tears being bilateral, and that upon the left side being usually the deeper; the hitherto uniform rim of the entrance to the uterine canal is now separated into two lips, one anterior and the other posterior, often unequal in size. In altogether exceptional cases a woman may give birth to a child without the slightest injury to the vaginal cervix, as far as careful subsequent examination can show, the cervix in all respects retaining its virginal character. These cases are, however, too few to invalidate the general law which has been enunciated. It is through traumatism that some of the most important functions of woman's sexual life are accomplished; and in childbirth there is more or less physiological traumatism involving the neck of the womb. The ovary has its surface made irregular by the ripening and rupture of hundreds of ovisacs during menstrual life, and is marked by innumerable cicatrices; in like manner, the higher function of childbirth causes important changes in the mouth of the womb; this is so torn and fissured by successive labors that it presents an irregular surface—elevations, depressions, and cicatrices marking the more or less complete healing of childbirth lesions; in women who have borne many children the cervix may be reduced to a small, button-like projection in the vaginal vault, atrophy being apparently in such cases nature's method of remedying the effects of the injuries.

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[1] Transactions of the American Gynæcological Society, vol. viii.

In the great majority of cases nature is quite competent to repair all physiological injuries received by the cervix in parturition, if the opportunity be given her. But this opportunity may fail; there may be neglect or ignorance in the management of the puerperal state; especially may there be want of proper and prolonged rest during the earlier weeks, and consequent imperfection of the process of repair. Again, all labors are not physiological. There may be, on account of increased size of the fœtal head, disproportion between this and the circle of the os uteri through which it must pass; labor may be too rapid, or the tissues of the cervix may fail in ready dilatability; by the application of forceps before the os is fully dilated, or by the indiscreet, not to say criminal, administration of ergot, the fœtal head may be dragged or driven through the os, bruising as well as tearing the tissues surrounding it; and like injury may be inflicted in podalic version where prompt delivery is necessary in the interest of mother or child. Nor is the puerperal state in all cases physiological. The necessary traumatisms of labor present avenues for the entrance of septic poison, and the consequent lymphangeitis, or phlebitis, requires a diversion of the forces of nature, it may be, from the repair of local injuries to the saving of life.

Laying aside, however, questions of the etiology of these normal lesions, as well as any explanation of nature's failure in certain cases to heal them, these unrepaired injuries are not innocent, but in many cases bring a train of more or less serious disorders, such as chronic parenchymatous metritis—too often regarded as sub-involution—parametritis and perimetritis, obstinate leucorrhœa, menstrual disorder—especially in the form of increased flow—ectropion of the mucous membrane of the cervical canal, hypertrophic elongation of the cervix, posterior displacements or prolapsus of the uterus, and reflex neuroses. It was reserved for Emmet to show how art can accomplish in such cases that which nature has failed to do, and his operation of *tracheloplasty* constitutes one of the most valuable of his many original and important contributions to practical gynæcology.

Dr. Emmet says that in the autumn of 1862 he accidentally discovered the importance of laceration of the cervix, and he at once instituted a surgical procedure for its relief; his method remains to-day essentially the same as that originally employed. In 1869, the operation was first described by him in a paper read before the New York County Medical Society, and published in the American Journal of Obstetrics. Since that time, in addition to other papers by Dr. Emmet, periodical medical literature, especially in this country, has contained numerous contributions upon the subject. The general acceptance of this procedure by the profession is probably only a question of time, but it is important that the operation shall be restricted to cases which actually require it. There can be no question that some surgeons,[1] in their blind enthusiasm, have forgotten the necessary and essential traumatisms of labor by which the nulliparous is changed into the parous os, and have with most unnecessary assiduity sought to obliterate these changes by tracheloplasty, when neither local nor general symptoms have required any operation. Conceding the general truth that the author of an important operation is unconsciously inclined to exaggerate its value,[1] either seeing only the facts which sustain it, or possibly misinterpreting others, we may in the main accept the indications for the operation given by Emmet; especially since he is much more conservative than many who are ostensibly his followers, but who very much exceed the limits within which he would restrain the operation. "The operation has been performed too often when no necessity for doing it existed. It has been done quite as often without the proper preparatory treatment, even while more or less cellulitis remained, and still oftener with no clearly defined purpose" (Emmet).

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[1] A lady who had been condemned to tracheloplasty, assured that she would never be well until the operation should be done, was carefully examined by the late Dr. Albert H. Smith and by myself; neither of us could discover the slightest indication, or even excuse, for an operation. She was quite well in three weeks, and has remained so for two years. In another instance the mother of six or seven children consulted an enthusiastic operator, who assured her that the condition of her cervix was the cause of her supposed acquired sterility; she was at that moment six weeks pregnant, and was afterward delivered at full term. Many similar instances might be quoted.

Avoidance of these very common mistakes is important, and attention should, therefore, be directed to the diagnosis of tears or lacerations of the cervix, to the indications for tracheloplasty, and to the treatment necessary before an operation.

DIAGNOSIS.—This is made by touch and by sight. By the former we recognize the position of the tear, to some degree its extent, and especially whether it causes increased sensibility. In the visual examination a cylindrical speculum should be rejected, and while some one of the many bivalve instruments may be used, the best of all is that of Sims; the patient occupies the usual position for examination with the last-named speculum, and after its introduction the anterior vaginal wall is pushed away by the depressor and the cervix exposed. The conditions represented by Fig. 1381 may be presented; or, instead of a bilateral tear, the laceration may be on only one side, or it may be stellate. It is well, in continuing the visual examination, to seize each uterine lip with a tenaculum and draw both together, thus proving that the angry-looking red surfaces which are presented, and which were regarded before Emmet's important discovery as the result of ulceration, are really caused by ectropion of the cervical mucous membrane; they disappear more or less completely when the lips are approximated. A uterine sound may also be used during this visual examination to ascertain the sensibility of the tear, especially at its highest part or angle, for in some cases, though the tear may be covered with healthy mucous membrane, there may be cicatricial tissue causing pressure upon exquisitely sensitive nerve-filaments at that angle, and this may be the origin of various reflex nervous disturbances; an operation in these cases is imperatively required for the liberation of the compressed nerves. Emmet describes also a laceration from within outward—where the injury does not extend through the thickness of the cervix—difficult of demonstration, although all the bad effects of the lesion are present. "Through the patulous os and canal the mucous membrane is seen prolapsed, and its appearance is like that presented after dilating with a sponge-tent, and where a partial contraction of the canal above has taken place, but has not yet extended to the external os. The cervix is frequently but little enlarged in diameter, but its walls are seen to be thinner than natural. The cervical discharge is most profuse and tenacious. The menstrual flow remains too free, and is often irregular, and the uterus is larger than normal" (Emmet).

INDICATIONS FOR TRACHELOPLASTY.—It must be remembered that, even if one or more lacerations be discovered, tracheloplasty is not necessarily indicated.

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[1] Emmet (Principles and Practice of Gynæcology, third edition, p. 447) makes the implied statement that a woman with bilateral laceration is sterile. This is an error: I have attended a patient in her second labor who had sustained such a laceration in her first. Again, it is an error to assert that nearly all, if not all, cases of epithelioma of the cervix have their exciting cause or origin in a laceration.

"Truly there are a great number of lacerations of the cervix, small and great, unilateral or bilateral, which do not cause any symptom, and which are cured or persist after cicatrization without producing any serious derangement of health" (Schwartz). "It should be clearly understood that old lacerations of great depth, and in all directions, may exist without a single morbid symptom, and without involving any necessity for surgical interference" (Thorburn). By Emmet's carefully prepared and extended statistics it was found that more than 32 per cent. of fruitful women had laceration of the cervix. Dr. Mundé makes the proportion less, only 25 per cent., and with a wise conservatism adds, "I esteem but a comparatively small proportion of all the cases of sufficient pathological importance to merit recognition as factors in the production of uterine disease." "The simple existence of a fissure in the cervix does not justify an operation for its closure, nor should the operation ever be resorted to except for the relief of symptoms which remain after the accepted treatment has been employed without apparent benefit" (Emmet).

Dr. Emmet, however, holds that when reflex symptoms exist, with enlargement of the uterus after all cellulitis has disappeared, and when the woman suffers from neuralgia or persistent anæmia, an operation is necessary, notwithstanding that the parts may have healed completely; and he believes that the thorough removal of the cicatricial tissue from the angles of the tear is absolutely necessary for success. Thorburn has wisely said that in order to justify an operation, the neuralgia referred to by Emmet, or nervous phenomena of severe character, should "be traced by exclusion to nothing else than uterine origin, and to the possible involvement of uterine nerves in the cicatricial tissue of the cervix. In this case, and in this alone, are we warranted in operating on a laceration covered with healthy tissue, and unaccompanied by great hypertrophic distortion of the cervix."

Preparatory Treatment.—Copious hot-water vaginal injections are used once or twice a day, until tenderness in the vicinity of the uterus, as shown by vaginal touch, is removed. The uterus should be lifted from the floor of the pelvis by a suitable pessary. Churchill's tincture of iodine is applied to the cervix twice a week, and, if the surfaces of the exposed cervical mucous membrane have become covered with granulations which bleed readily, an application may be made weekly of subsulphate of iron or Monsel's salt. Cystic degeneration of the mucous follicles is relieved by puncturing the cysts with a small lance-shaped knife, and then freely applying iodine.

Operation.—It is usual to have the patient anæsthetized, though the operation is not, as a rule, very painful; she is placed in the dorsal position with her hips brought so as to project somewhat over the end of the table; some operators prefer the lateral position. After an antiseptic injection into the vagina, the perineum is retracted by a Sims's or a Simon's speculum, the cervix is exposed, and the anterior lip is seized with tenaculum forceps; the cervix is now drawn gently toward or to the vulva. Next a straight needle threaded with strong silk is passed[1] through the median line of the anterior lip, near its margin, and then similarly through the posterior lip; the silk is caught with a tenaculum where it crosses from the anterior to the posterior lip (Fig. 1379), and is drawn down and cut; the two ends of the thread passing through each lip are then tied together, and thus is secured perfect control, not only of the cervix, but also of each flap, and ready exposure of the surfaces to be denuded. The denudation may be effected with knife or scissors, most operators preferring the latter as enabling the operation to be done with greater rapidity and with less hemorrhage; it should be symmetrical as to each lip, and it should leave in the median line of each an undenuded surface somewhat resembling an elongated triangle in shape, the base being below; the two surfaces, when the lips are united, form the restored cervical canal. "The shape and size of the flaps determine the amount of tissue to be removed. Sometimes, when the lips are not much thickened and present a flat surface, it is necessary to take off a thin layer; but when they are hypertrophied and have a rounded, bulging surface, the entire convexity should be cut away" (Jackson).[1] In some cases, where the tissues are dense at the angles of the rent, a knife will be necessary for denudation. Skene[2] uses hawk-bill scissors (Fig. 1380), by which he finds that denudation at the angles, as well as elsewhere, can be accomplished accurately and with facility.

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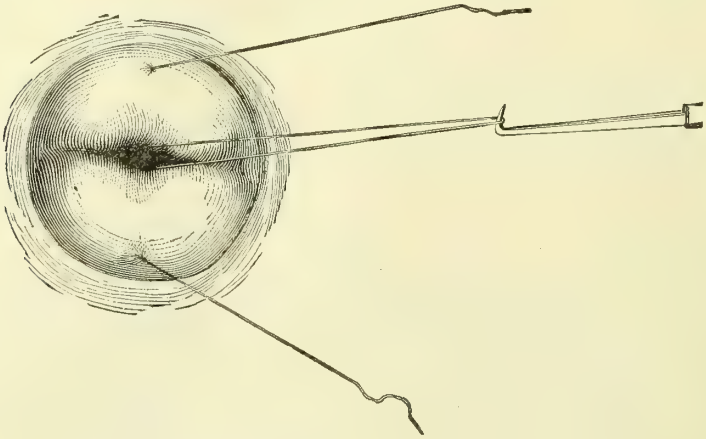
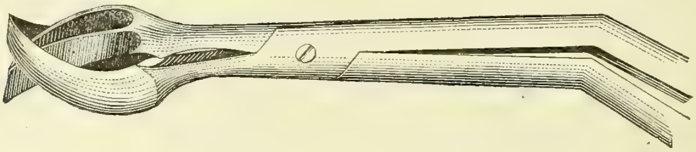
[1] This is the method of Dr. Reeves Jackson, of Chicago, and certainly it is much more convenient than the use of a double tenaculum with diverging branches, or of two tenacula.

Fig. 1379.



Introduction of ligature to secure lips of cervix by Jackson's method.

Fig. 1380.



Skene's hawk-bill scissors.

The sutures, varying of course in number with the depth of the tear, usually from two to four on each side, are generally of silver wire. Skene, however, prefers braided silk (No. 7), "prepared by being immersed for several hours in melted beeswax mixed with five per cent. each of carbolic acid and salicylic acid. When thoroughly saturated, the silk is passed through a hole in a piece of cardboard, or the eye of a needle, to remove the excess of wax."

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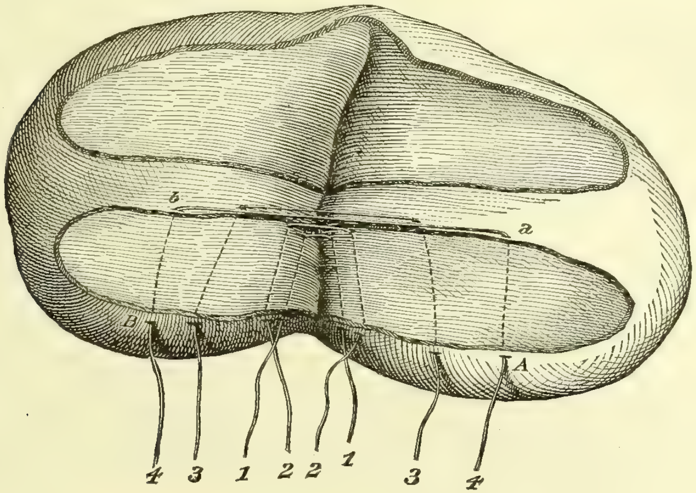
[1] American Practitioner, 1880.

[2] Holmes's System of Surgery. American edition.

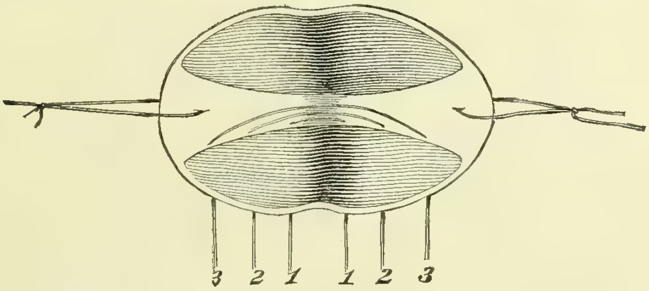
A sharp-pointed, triangular needle, or one which is lance-pointed or bayonet-pointed, and about three-fourths of an inch long, may be used for introducing the sutures; the first suture introduced is that at the angle of the tear, and, if the tear involve both sides, the sutures should be applied alternately to either. The needle is entered externally about one-fourth of an inch from the margin of the freshened surface, and, after penetrating one lip, is made to enter the other from within, and then to come out upon its external surface. Fig. 1381, borrowed from Emmet, shows the denuded surfaces,

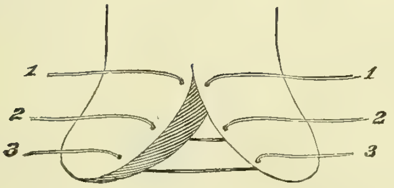
Fig. 1381.

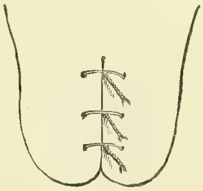


Tracheloplasty. (After Emmet.)

Fig. 1382. Fig. 1383. Fig. 1384.







Tracheloplasty. (After Thorburn.)

and the sutures introduced upon one side, in a bilateral tear. The first three sutures are numbered according to the order of their introduction; the fourth, it will be seen, enters at A, and passes out at that which is to be one of the walls of the cervical canal at *a*; enters again at *b* of the other lip, and passes to its external surface at B.

If silver wire is to be used for the sutures, each is bent and hooked upon the silk loop which is carried by the needle, and is thus placed in position. Each suture is fastened by twisting its ends; it is then bent over so as to lie close to the cervix, and is cut off at half an inch in length; some prefer compressed shot for fastening the sutures, and these may also be used if the stitches are of silkworm-gut. Figs. 1382, 1383, and 1384, copied with some modifications from Thorburn, show various steps in the operation of tracheloplasty.

AFTER-TREATMENT.—Skene applies around and below the cervix a tampon of marine lint, which is removed in forty-eight hours, when, if there is any suppuration, a fresh one is introduced. Jackson places in the vagina a cotton tampon saturated with glycerine, has it removed in twenty-four hours, and has the vagina syringed once or twice daily with warm water slightly carbolized. Emmet directs a vaginal injection of warm water once a day, or night and morning, if there should be much discharge. The patient remains in bed for two weeks; the diet is not especially restricted; the bladder is emptied by the catheter, or spontaneously in the bed-pan, and the bowels may be moved every other day, but the evacuation must be without the patient sitting up; the stitches are removed in eight or ten days, but the patient keeps her bed for a few days longer.

ACCIDENTS DURING AND AFTER THE OPERATION.—Hemorrhage during the operation generally arises from a wound of the circular artery, or of one of its branches; if it does not yield to applications of hot water, it is arrested "by passing the first suture through the vaginal tissue, a short distance below the angle of the laceration" (Emmet). Secondary hemorrhage may occur within a few days after the operation, and in some cases is very serious. Hot-water injections should be used, and, if these do not arrest the flow, the cervix should be exposed, and a suture applied on the side of the neck from which the blood comes; or finally the tampon may be required. Sloughing of a part of the cervix may occur from one or more sutures being drawn too tight; this of course is an accident which may be prevented by proper care during the application of the stitches. Pelvic inflammation—parametritis or perimetritis—may follow the operation, and in some cases may result fatally. The statistics of Wells[1] show one death in about two hundred and fifty operations. This mortality is probably understated, for the operation is being done by hundreds of surgeons in this country, and fatal cases are more likely to be unpublished than successful ones. I know myself of seven unpublished fatal cases, and it is probable that the actual mortality of the operation is nearly one per cent. The deaths in most of the cases are probably the consequence of septicæmia, and therefore in some degree from a preventible cause. While the mortality is not great in view of the important benefits which this procedure confers when employed in suitable cases, and while proper precautions will no doubt very much lessen this death-rate in the future, it is important that the operation should not be regarded as entirely devoid of danger, and thus rashly advocated or recklessly performed.

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[1] American Journal of Obstetrics, June, 1884.

TEARS OF THE PERINEUM.

By tear, laceration, or rupture of the perineum, is meant a violent division, complete or incomplete, of the tissues interposed between the lower portion of the rectum and the vagina.

This condition has been caused by the extraction of a large uterine polypus from the vagina of a nulliparous woman; by falling so that the perineum has struck upon the upper part of the back of a chair (Hildebrandt); by injury from the horn of a bull, as in a case reported by Bauer,[1] of a servant girl who, while stooping down, milking, in a pasture, was attacked by the animal coming behind her, thrusting his horn into the pudendal rima, and then suddenly raising his head—the perineum was completely torn—or from the horn of a goat,[2] as happened to a delicate woman, 20 years of age, who, carrying a heavy load, did not see a goat lying down just in front of her upon a bridge she was crossing, when the animal, suddenly starting up, thrust one of his horns into her rectum from behind, a little above the anus, the horn then penetrating the vagina, and, as the woman sank back, tearing the lower portions of the rectum and vagina, and the perineum; it has also occurred from jumping out of a wagon on a pile of hay, the handle of a concealed hay-fork penetrating the body at the pudendum, and completely tearing the recto-vaginal septum;[3] and from brutal violence—as in the case of a girl eight years old, violated by a man of twenty-three, not only almost the whole perineum being torn, but also the posterior vaginal *cul-de-sac*—[4] and in that of a wife whose husband inflicted the injury because he suspected her chastity.[5] But the accident occurs far more frequently from childbirth than from all other causes. It may occur in either natural or artificial labor. Among its causes in labor are unusual height of the pubic symphysis, narrowing of the pubic arch, lateral deviation of the coccyx, and abnormal concavity of the sacrum. The perineum may be abnormally prolonged in front,[6] so as to greatly shorten the vulvar orifice, or it may be undilatable,[7] as in old primiparæ, or as the result of cicatrices from previous traumatisms, scrofula, or syphilis; there may also be unfavorable presentations or positions of the fœtus, deviations from the normal mechanism of labor, abnormal size of the fœtus or incompressibility of the head, so that moulding is impossible or insufficient, malformations of the fœtus, monstrosities, etc. The position of the parturient at the close of the second stage of labor has an influence in causing a perineal tear, this accident, for example, being more likely to occur if she is lying upon her back, or if she is in a half-sitting posture, than if she is lying upon her side. Violent uterine contractions, and great voluntary effort, may cause the accident. So, too, in a case of pelvic presentation, the obstetrician may, while bringing down an arm that has departed from the chest, or in the rapid delivery of the head—made necessary in the interest of the child—cause tearing of the perineum. Delivery with the forceps is not an infrequent cause of the injury in question. But here, too, we must regard the result as coming from the rapid delivery which the forceps renders possible, and which may be necessary in the interest of the child or mother; in cases in which immediate delivery is not required, the forceps may be so used as to save the perineum from a tear which would occur in natural labor.

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[1] Wiener medizinische Wochenscrift, 1881. [2] Curran, Edinburgh Medical Journal, 1872.

[3] Kaltenbach, Zeitschrift für Geburtshülfe und Gynäkologie, 1879.

[4] Colles, Medical Times and Gazette, 1860. [5] Roux, Gazette Médicale, 1834.

[6] But if the deviations from the normal length of the perineum are slight, it seems, from Fasbsender's statistics, that the shorter is in greater danger than the longer perineum. Thus in three series of subjects in which the perineum was two centimetres, from two to three, and three centimetres, the relative proportion of lacerations was in order 53.8, 33.3, and 24.4.

[7] Kleinwächter states that in 50 per cent. of primiparæ over thirty years of age, the perineum is torn.

Considering in general the etiology of this injury, it may be said that, in the great majority of cases, it is due to too rapid delivery of the fœtus—delivery before the tissues have had time to undergo physiological softening and stretching.

VARIETIES.—Lacerations of the perineum may be complete or incomplete. In the *complete* form the tear extends from the vulvar to the anal opening, and involves the rectal wall, usually for from about a half to three-quarters of an inch—rarely, according to Hegar, an inch and a half; in the *incomplete*, the tear may extend half way to the anus, or as far as its sphincter; sometimes only the skin is torn; in some cases the perineum is perforated, the anal and vulvar sphincters being uninjured—the so-called *central* laceration; in others the tear is in the posterior part of the perineum, and the injury extends through the anal sphincter and the recto-vaginal wall. It should be borne in mind that, as pointed out many years ago by the late Dr. Dewees,[1] and more recently by Dr. J. Matthews Duncan, the perineum, though apparently perfect at the close of labor, may have been subjected to such injurious pressure by the long delay of the head at the vulva, that sloughing afterward occurs, and that in a few days a more or less complete laceration is evident.

FREQUENCY.—According to Kleinwächter,[2] this accident occurs in between 15 and 40 per cent. of primiparæ, and in from 1 to 10 per cent. of multiparæ.

TREATMENT.—The prophylaxis of this injury belongs so exclusively to obstetrics that it will not be here considered. The curative treatment includes the immediate or primary, and the secondary operation; the former, appropriately called *perineorraphy*, is an operation done within at most sixteen hours after the injury has occurred, and the latter, *perineoplasty*, is one done when involution of the sexual organs has taken place, six or eight weeks after labor. The intermediate operation, that is, one done between the fifth and tenth days, has been rejected from its liability to be followed by septicæmia.

I. PERINEORRAPHY.—The majority of obstetric authorities hold that a torn perineum should be, in all but exceptional cases, stitched as soon as practicable after the injury, or that, at least, the operation should not be delayed more than sixteen hours. The reasons for adopting the immediate operation are the serious hemorrhage which may occur from the wound, the risk of septic infection taking place through the raw surfaces, and the slight probability of spontaneous cure of the injury.

The operator will need a disinfectant solution—one part of corrosive sublimate to 5000 of water, for example—sponges, a pair of scissors for trimming off any ragged projections of torn tissue, needles, needle-forceps, material for sutures, and perforated shot with shot compressors, if this mode should be chosen for fastening the stitches. Horse-hair, silk-thread, silkworm-gut, catgut, and silver and iron wire have been used successfully for sutures; probably silver wire has been oftener employed than any other material, though the continuous catgut suture, used as will be described in perineoplasty, presents many advantages. If no vaginal or rectal stitches are necessary, an ordinary large sewing needle, about an inch and a half in length, straight, and properly annealed, answers the purpose as far as external stitches are concerned; Dr. Thomas, however, advises a straight darning needle, while many prefer long, flat, curved needles; these may be threaded with silk, and to this the permanent suture—silver wire, silkworm-gut, or catgut—may be attached, and thus drawn through the tissues. If stitches are used internally also, it is better to have a shorter needle, one curved near its point. As a rule, large needles are to be rejected from the fact that they inflict a wound which may give rise to oozing of blood, or even to the occurrence of a thrombus; the smaller the wound made, the better, and for a like reason a conical needle is usually to be preferred to one with cutting edges, or even to a flat needle.

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[1] System of Midwifery.

[2] Real-Encyklopädie der gesammten Heilkunde. Bd. iii.

The patient lies in the dorso-sacral position, with her hips near the edge of the bed; the vagina is washed out and the wounded surface well cleansed with the disinfectant solution, and in a similar solution the sponges also are thoroughly washed; the operator takes like precautions as to his hands and instruments, a carbolized solution being used for this purpose, and all care being taken to make the operation completely aseptic. A sponge is placed in the vagina above the rent so as to absorb the discharge from the uterus, and thus prevent its hiding or obscuring the field of operation; the propriety of using an anæsthetic will be decided by the patient's condition, and by the length and severity of the operation, but in no case should there be an approximation to complete anæsthesia, lest consequent uterine relaxation should cause dangerous hemorrhage.

If it be necessary, any loose shreds of tissue are cut off from the wound, and then, the index finger of the left hand being in the rectum, the needle, armed as already directed, is made to penetrate the skin near the angle of the wound, in partial rupture, half an inch from its margin, and is carried through the tissue intervening between the rectum and the vagina, guided by the finger in the former, and made to emerge at a corresponding distance from the margin of the wound on the opposite side; if difficult or impossible to pass the entire distance with the needle at once, it may be drawn out in the middle of the furrow, and reintroduced. The silver wire is now looped on the silk, and made to follow its course; the two ends of the wire are loosely twisted or tied, and then one or more additional sutures are passed, as may be thought necessary, to secure apposition of the entire torn surfaces. Finally, the wires are twisted, or secured by perforated shot. Care must be taken to prevent such constriction of the tissues that the sutures will cut out. If the material for sutures be silk-thread, silkworm-gut, or horse-hair, the ends of the suture are tied; care must be taken in all cases that the torn surfaces are brought in close and accurate contact, no clots of blood intervening, and that inversion or eversion of any part of the margins is prevented. Superficial sutures are rarely, if ever, necessary. If vaginal or rectal sutures are used, these should be introduced first, and they should be fastened before the external sutures. If the laceration is complete, and if only external sutures are used, the first and second sutures, or more, will, as introduced, appear in the deepest part of the rent, crossing near the rectal surface.

Dr. Alloway[1] advises using only one suture in incomplete rupture. He uses Emmet's straight perineum-needle, and a silk suture; the needle is entered on the left side of the tear, half an inch from its margin, and near the upper part of the rent, or that which was first torn; "two fingers of the left hand in the rectum press up the rectal wall and recto-vaginal cellular tissue, so that the needle can be rapidly, though steadily, made to glide beneath this tissue and over the rectum, hugging the latter as closely as possible;" and the needle passes out at a point on the opposite, or right side, corresponding to that on the left side at which it entered. Koeberlé freely divides the anus posteriorly, the incision extending beyond the circular fibres and involving the connective tissue behind the rectum. Schroeder advises posterior subcutaneous section of the sphincter.

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[1] American Journal of Obstetrics, January, 1884.

After-treatment.—By many it is held to be important to tie the knees together, to catheterize the bladder at stated intervals, and to keep the bowels confined for a week or more. By no probable movement of the limbs can there be any strain upon the perineal tissues now sewed together—tissues that have undergone the very great stretching necessary for the passage of the child—and therefore the bandage about the knees is unnecessary; moreover, the bandage increases the discomfort of the patient, helps to imprison the lochial discharge in the vagina, and is thus injurious. Hildebrandt objects to the use of the catheter because vesical catarrh is very liable to result, and thinks it better for the urine to be discharged spontaneously, if possible. Once in twenty-four hours, the vagina should be carefully washed out with a warm antiseptic injection. On the third day, the bowels may be moved by castor oil or by "liquorice powder," assisted by an enema of warm water or of olive oil; subsequently an evacuation should be had at least once in forty-eight hours.[1] The diet may be of peptonized milk, broths or soups containing a little rice, milk-toast, and eggs slightly cooked. The common practice is to remove the sutures from the eighth to the tenth day; Schatz,[2] however, advises leaving them for two weeks, and this is probably the better plan. For two weeks at least the patient should remain in bed.

II. PERINEOPLASTY.—Two preliminary conditions are important for the success of a perineoplasty: first, the patient's health must be good, and, second, the bowels must be free from any accumulation of fecal matter. In order that the latter condition may be secured, it is advisable for the patient to have a free movement each day for a week before that fixed for the operation. Thomas directs the use of a compound cathartic or compound aloetic or rhubarb pill, or a saline cathartic, every twelve hours; Emmet advises twenty grains of inspissated ox-gall each day, and every other night a purgative of rhubarb and carbonate of sodium, and, as an additional precaution, especially when the patient has been careless in her habits, a large enema of hot water in which fresh ox-gall has been stirred, given with the patient in the knee-chest position.

The patient is anæsthetized, and is placed in the lithotomy position, while an assistant on each side holds the lower limbs strongly flexed on the body, and the hips are brought close to the edge of the table and strictly on a line with it, for if these be oblique, there is danger that the operator will make the denudation of tissue unequal on the two sides. Supposing the rent to be incomplete, the operation as usually done embraces, first, the preparing on each side of two raw surfaces having very nearly the form of spherical triangles, which of course must be equal, so that when the sutures are fastened these two surfaces may accurately fit together. The surfaces may be freshened with scissors or knife—the former are generally preferred. The operator may with the scissors make a slight cut in the median line upon the recto-vaginal wall, to mark the apex of the surface to be freshened, and a similar cut on each side of the vulvar orifice at points directly opposite, to mark the anterior limits of the denudation. The assistants who hold the lower limbs, also with the thumbs, or with the index and middle fingers of the hands next the patient, retract the labia, pressing downward and outward, so that the surfaces to be denuded are freely exposed and made level. The operator begins upon one side at the lower margin of the vulva, cutting a thin strip of tissue—forceps or tenaculum being used to hold the part first cut—carries the section to the opposite side, then back again, and thus on until the entire surface is denuded. Hemorrhage is rarely troublesome, especially if scissors are used, and should it occur in this or any other perineoplastic method, may be arrested by hot water, or by compressing or tying with catgut the bleeding vessel; care must be taken not to cut a varicose vein if such should be found, as is sometimes the case, just at the vulvar entrance.

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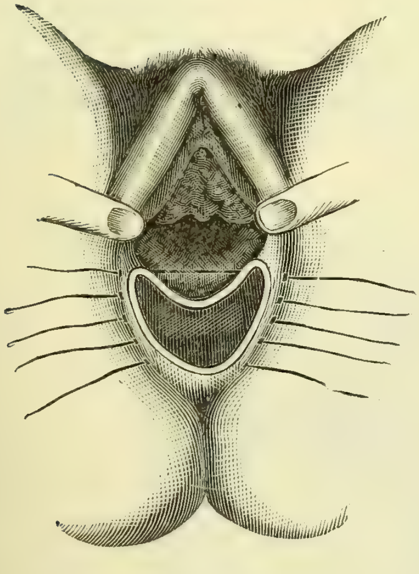
[1] In two cases upon which I have recently successfully operated for rupture of the perineum involving the anal sphincter, the following plan was followed in securing every day or every other day during the after-treatment an evacuation of the rectum without risk to that muscle: A saline laxative was given, and two or three hours afterward a rectal tube was introduced, and through it successive injections of warm water were administered, not more than half a pint being used at a time, and after each injection the water and feces being discharged through the tube. By means of several injections all intestinal masses were softened, and the bowel was completely emptied without there being the least stretching of the anal sphincter. This method requires considerable time and some care and patience, but I believe that it is worthy of a trial at the hands of others.

[2] Archiv für Gynäkologie, 1884.

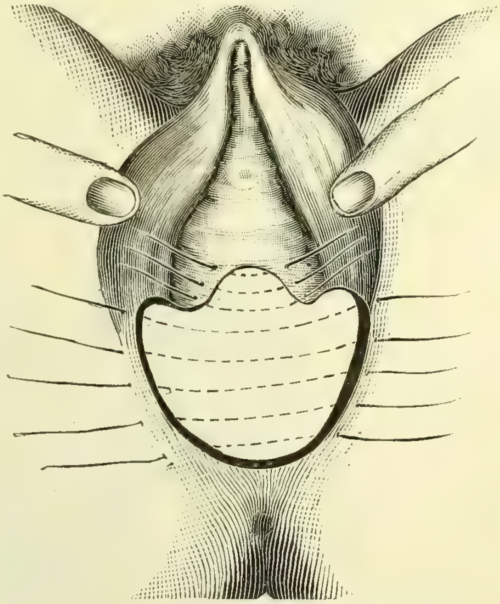
Fig. 1385 represents the denuded surface with the sutures introduced; it will be observed that the latter, with the exception of that last introduced, lie in the recto-vaginal wall, and are completely hidden.

Fig. 1385.



Perineoplasty. (After Thomas.)

Fig. 1386.



Perineoplasty; "butterfly" denudation. (After Hildebrandt.)

In Fig. 1386, from Hildebrandt,[1] the "butterfly" form of freshened surface is represented; in this too the sutures are indicated, and it will be observed that, in addition to the external or perineal sutures, there are three vaginal stitches. The broken lines of the sutures appearing at the denuded surface, are given this form to indicate that they are buried beneath the surface.

The Flap Method.—In the operation hitherto represented, the tissue obtained in denuding the surfaces is cut away, but in the method by flaps it is retained.

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[1] Billroth, Handbuch der Frauenkrankheiten.

The following illustrations, modified from the Manual of Gynæcology by Berry and Hart, show one of the methods used; it is impossible and unnecessary to describe all the varieties which have been proposed or practised by different operators.

Fig. 1387.

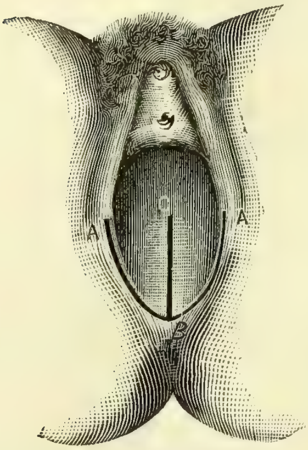
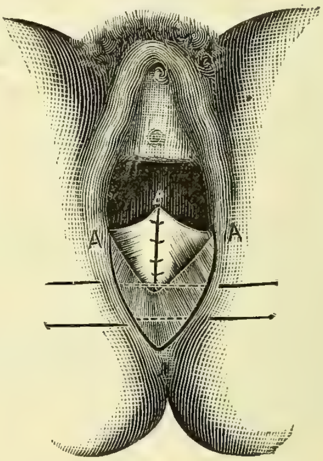


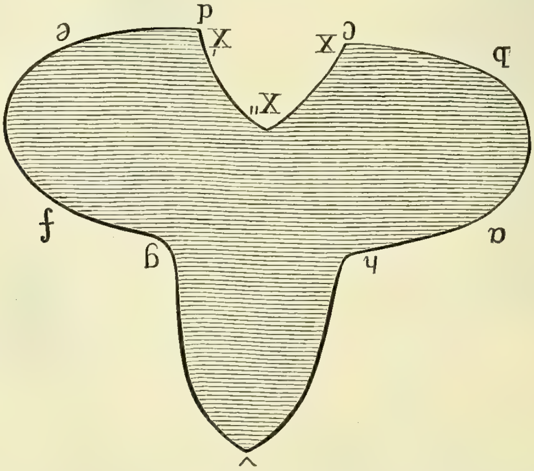
Fig. 1388.



Perineoplasty; flap method.

In the operation represented above, an incision is first made from B to C (Fig. 1387), and then on each side an incision from B to A; two triangular flaps are then made which are stitched together, the lowest point of each (Fig. 1387) becoming the highest (Fig. 1388). Two deep sutures are passed (Fig. 1388), bringing the raw surfaces together in the median line, while the thin edges are united by superficial stitches.

Fig. 1389.



Perineoplasty; Hildebrandt's method. The surfaces *a b c h*, *f e d g* are the lateral parts of the perineum, while *c h g d* represents the part next to the rectum; *b c d e* will form the raphe, and *a b* with *f e* will make the anterior margin of the perineum; the gap in the rectum is shown by *x x' x''*; *h g v* represents the denudation upon the posterior vaginal wall.

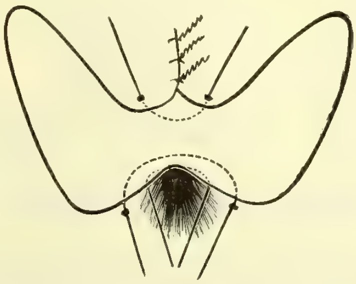
In complete rent of the perineum, the operation may be by flaps, the *perineosynthesis* of Langenbeck, by other methods which imitate it, or by triangular denudation. The former can only be employed when the tissue is abundant and rich in vessels, and then there is often difficulty in hæmostasis, success is less constant, and the mortality is greater; for these reasons it is rejected by Hegar and Kaltenbach.

The preparation of the patient, her position, and the duties of the assistants who support her lower limbs, are the same as in the operation for incomplete perineal tear.

The accompanying illustration (Fig. 1389) from Hildebrandt[1] gives the form of denudation recommended by him.

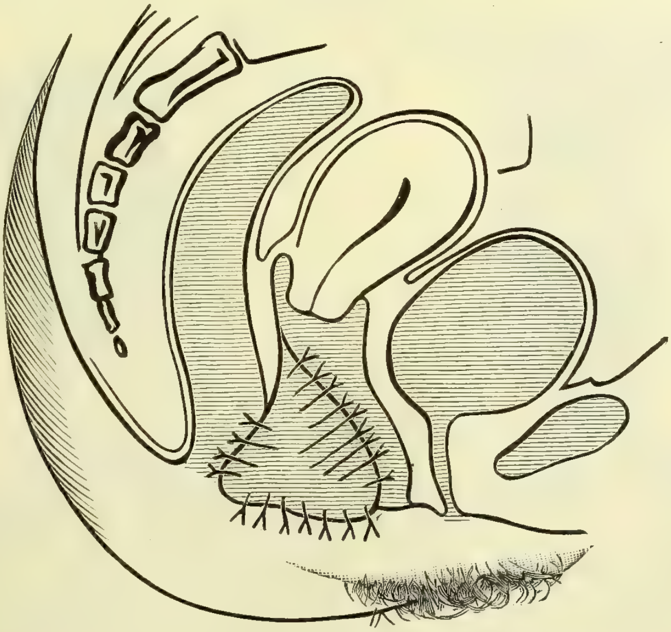
Hildebrandt suggests—in addition to the means already mentioned for the arrest of bleeding, which is rarely troublesome, especially in cases where the rent has existed for some time—digital compression by the thumb in the vagina and the finger in the rectum. In the three sets of sutures advised—vaginal, rectal, and external—he regards it as important that only one set should be deep, the others superficial. He passes all the sutures before fastening any, but Hegar and Kaltenbach advise, after the introduction of the deepest suture, to fasten it so as to see the result obtained, and then to introduce and fasten the second suture in like manner, correcting, if necessary, the form of the freshened surface, and securing more accu-

Fig. 1390.



Perineoplasty; Hegar and Kaltenbach's mode of fastening the sutures.

Fig. 1391.



Perineoplasty; the sutures fastened. (After Hegar and Kaltenbach.)

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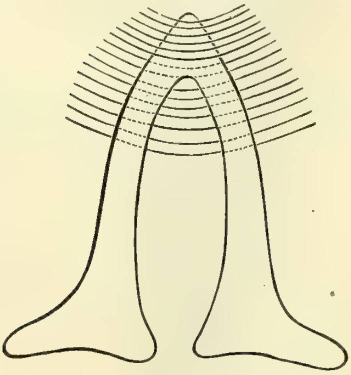
[1] Billroth, Handbuch der Frauenkrankheiten.

rate apposition of the lips of the wound. Fig. 1390 shows three of the vaginal sutures fastened, with one vaginal and two rectal stitches free. In Fig. 1391 the three sets of sutures are represented as introduced and fastened.

In Fig. 1392 there is represented the form of denudation required when the tear extends up to the vaginal *cul-de-sac* (Kaltenbach's case); the ascending branches of freshened tissue appear as if widely separated, so that the disposition of the sutures can be readily seen, although in reality their surfaces are parallel to each other.

Fig. 1392.



Perineoplasty; denudation extending to vaginal cul-de-sac. (After Hegar and Kaltenbach.)

In the operation as performed by Emmet, two important points are presented, one relating to the denudation, the other to the insertion of the first stitch. He says that if the posterior portion of the surface in an old complete laceration be carefully examined, there will be found on each side a little pit or depression caused by contraction of a portion of the fibres of the anal sphincter, and that it is essential that the tissue at these points should be thoroughly denuded. The second point relates to the introduction of the first suture in proper relation to the edges of the divided muscle. In Fig. 1393 the suture is seen introduced superficially, but the anal sphincter is not restored to its proper place and use—the mouth of the purse is formed, but the purse string is wanting—and hence involuntary passing of gas or feces. In Fig. 1394 the suture A B is superficial, as in Fig. 1393; but, on the other hand, C D is introduced so far back, running obliquely across the rectal extremity, that by securing it the divided edges of the sphincter are turned up and brought into perfect apposition.

Fig. 1393.

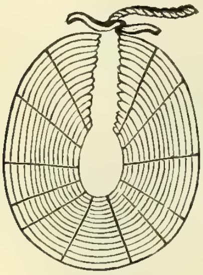
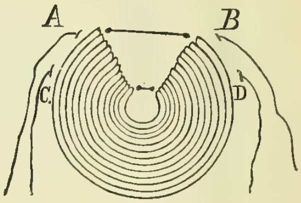


Fig. 1394.



Perineoplasty; Emmet's method.

When either rectal or vaginal sutures are used, it is better that they should be of catgut, silkworm-gut, or silk. The continuous or spiral catgut suture gives good results, both in perineorraphy and in perineoplasty (Schroeder, Bröse, Doléris[1]). The catgut is prepared by soaking it for twelve hours in Van Swieten's liquor, and it is then put in oil of juniper, and kept in rectified alcohol; before being used, it is dipped in a four-per-

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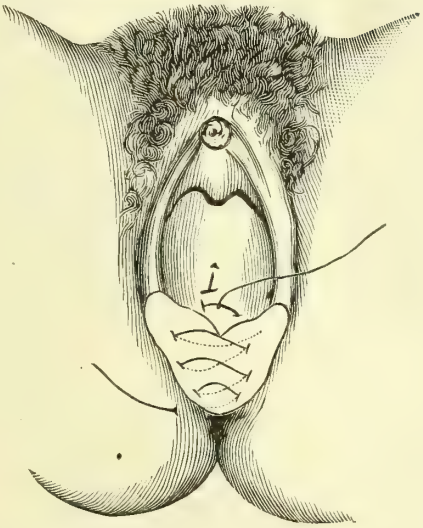
[1] Archives de Tocologie, Fév. 1885.

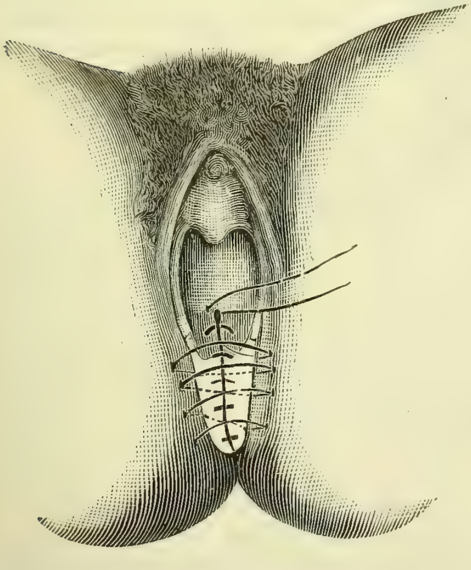
Fig. 1395.



Perineoplasty by continued suture (catgut); deep suture beginning at the vaginal angle, and descending to the anal angle.

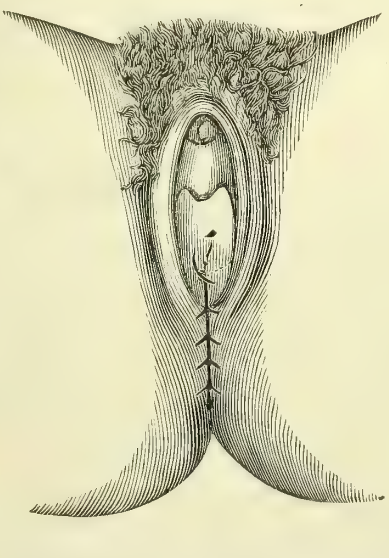
cent. solution of carbolic acid. The stitching is begun at the vaginal angle of the tear; a double stitch is made, and the catgut tied, and then the needle is carried from side to side, making a spiral suture from above downwards until the anal margin of the wound is reached. (See Fig. 1395.) The next step is to sew up the perineum proper by a series of similar stitches. Finally, the initial and terminal ends of the catgut are tied together. If the rent be deep, two sets of vaginal sutures, one deep and the other superficial, are advisable. Doléris advises to knot the thread from time to time in the course of the stitching; he says that absorption of the catgut takes place in seven or eight days. Bröse[1] has the catgut washed in *himmel*, rendered aseptic by a corrosive-sublimate solution, and preserved in absolute alcohol; he finds No. 2 Lister's catgut not too large, though he rejects that prepared according to Lister's method. Schroeder[2] strongly recommends the use of catgut in perineoplasty. He uses only distilled, that is, sterilized, water in cleansing the

Fig. 1396.



Deep sutures drawn tightly, and superficial sutures just introduced.

Fig. 1397.



Completed operation, the surfaces in apposition, and the ends of the sutures tied.

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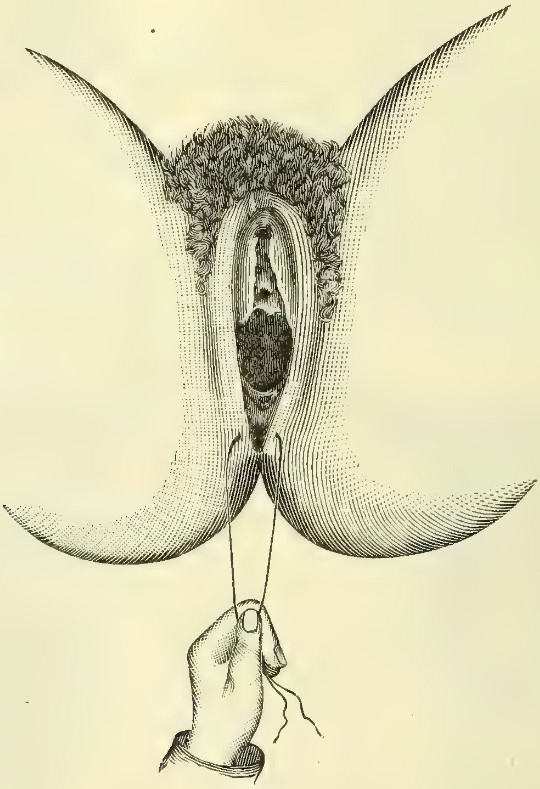
[1] Centralblatt für Gynäkologie, 1883.

[2] Ibid., 15 Juli, 1885.

wounded surfaces, makes a subcutaneous section of the anal sphincter posteriorly, and, after the operation, fastens the patient's lower limbs together, and confines her to bed for three weeks; the catgut is absorbed within nine days. Veit irrigates the wounded surfaces with one-to-ten-thousand corrosive-sublimate solution; he also uses catgut.

In concluding the consideration of the treatment of ruptures of the perineum, I desire to mention a step which I have found useful at the beginning of a perineoplasty when the tear has been complete. The surgeon takes a needle threaded with catgut, and, entering it externally a little behind the anal rent, passes it upward about half an inch, so that it includes a part of the rectum close to the tear on that side; then turning it directly across, he makes it similarly embrace corresponding tissues upon the other side, emerging through the skin. The method is shown in the subjoined illustration. By firmly pulling the two ends of the catgut, the complete tear is temporarily made incomplete, and the surfaces to be denuded are better exposed and rendered more fixed. After the denudation the suture may be withdrawn; or it may be tied, and made to assist in keeping the parts which are to unite in apposition.

Fig. 1398.



Perineoplasty; catgut suture approximating walls of vagina.

TRAUMATISM INVOLVING THE GENITAL ZONE IN PREGNANCY.—The genital zone includes the vulvo-uterine canal and the perineo-anal region. Traumatism, whether accidental or from surgical operations, has been in many cases followed by abortion or premature labor, the liability to the interruption being increased if the traumatism involve the genital zone. Cohnstein[1] says that through the anatomical disposition of the connective tissue around the uterus, in the broad ligaments, and generally in the pelvis; through the hyperplastic processes which the vulva, the vagina, the uterus, and the pelvic connective tissue undergo in pregnancy, and which is increased by the presence of tumors; and, finally, through expansion of veins and dilatation of lymphatics, the entrance of poison from an infected wound is facilitated. His statistics show that while 45.5 of pregnant women submitted to surgical operations, aborted, or had premature labor, in 32 per cent. of these the operations involved the uro-genital organs.

The statistics of Mann[2] indicate that surgical operations upon the pregnant woman are less dangerous to the pregnancy than has been believed. He gives among his conclusions the following: Operations on the vulva cause little danger to mother or child, while those on the bladder are not dangerous. Operations on the vagina are likely to cause severe hemorrhage, but are not otherwise dangerous, while those upon the rectum involving the anal sphincter are so. Operations upon the perineum and upon the cervix may be done in the earlier months of pregnancy with a fair prospect of success. While the general truth indicated by Mann's statistics may be admitted, all his conclusions cannot be accepted; indeed, the number of observations which he has collected is too small to justify the formulation of absolute rules. Removal of the cancerous cervix may be necessary in pregnancy, and in the majority of cases has been done without evil result, but all plastic operations, especially those upon the cervix, the perineum, and the vesico-vaginal wall, should if possible be postponed until after delivery. Guéniot[3] says that if the lesion affects the genital zone, it is not unusual to see the pregnancy interrupted, and that a surgical operation involving this region is formally contra-indicated by gestation, unless in case of necessity.

FOREIGN BODIES IN THE VAGINA.

The vagina has been the receptacle of the most diverse objects, introduced accidentally or intentionally, by the subject herself or by another. In some cases the foreign body has entered the vagina of a woman or girl by her sitting or falling on it; in others it has, while being used in self-abuse or in an attempt to cause abortion, escaped the patient's hand; in still other instances, a young girl, surprised by the monthly flow, has pushed into the vagina a spool, for example, with the vain hope of stopping the hemorrhage that has so alarmed her; and in other cases a sponge has been introduced into the vagina just before coition, and then, either being forgotten or receding from the subject's reach, has remained for months or years. A glass pessary, a syringe, or a thermometer, has in some cases been broken in the vagina, and its fragments have required removal. The vagina has been made a place of concealment; for instance, a purse of money has been hidden in it. In other cases the foreign body has been introduced voluntarily, in thoughtlessness, or from a morbid desire to excite sympathy or wonder.

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[1] Ueb. Chirurg. Op. bei Schwangeren.

[2] Transactions of American Gynæcological Society, 1883.

[3] Annales de Gynécologie, 1876.

Instances where a foreign body has been introduced into the vagina by the cruel brutality of men, are not wanting. Such was the case coming under the care of Dupuytren, of a girl who, after being violated by some soldiers, was further subjected to injury by having a pomade-pot thrust into the vagina. A peasant forced into the vagina of his idiotic wife a broken wineglass; a young man, after having intercourse with a girl, placed a large crystal of sulphate of copper in her vagina; three farm-hands tore the external sexual organs of a maiden, partly with their fingers, and partly with stones which were used to fill up the vagina. Among other abominable cruelties of this kind may be mentioned the introduction of a turnip, and of the cone of a fir tree.

Most frequently the foreign bodies which the surgeon is called to remove are pessaries that have been improperly introduced, or that have been worn too long. A tampon, used to arrest uterine hemorrhage, has been forgotten, and has remained in the vagina for many months.

The effects produced by foreign bodies in the vagina vary with the injury done in their introduction, with their size, form, and material, and with the length of time which they remain. There may be wounds of the external genitals or of the vagina, or the foreign body may through the vagina penetrate adjacent organs.

Foreign bodies usually produce more or less irritation of the vaginal mucous membrane, with increased secretion. In many cases an obstinate leucorrhœa, compelling the patient to seek professional advice, leads to the discovery of the foreign body. The increased vaginal discharge is at first mucous, then muco-purulent or purulent, or it may be serous; after a time it becomes more or less offensive in odor, in some cases so offensive as to suggest malignant disease, a suspicion which may be confirmed by the occasional or frequent occurrence of hemorrhage. The foreign body may interfere with the functions of neighboring organs, especially those of the bladder and rectum; hence vesical irritability or dysuria, rectal tenesmus, and in some cases dysentery.

The vaginal surface may be abraded, or ulceration of the walls may occur, from pressure of the foreign body; adding to these lesions the offensive character of the retained vaginal secretions, we have the conditions which may lead to septic infection. Kottman has reported a death from this cause in a woman twenty-five years old, who had introduced a spool into the vagina, and who had subsequently suffered from leucorrhœa for several years. The spool was found behind the cervix, in the vaginal vault, and removed; symptoms of peritonitis were well marked, and the patient died; an autopsy showed purulent exudation in the pelvic peritoneum, especially in the recto-uterine *cul-de-sac*, at a point corresponding with that which the spool had occupied in the vagina.

Runnals[1] has reported a case of death from pyæmic pneumonia and peritonitis, occurring in a girl of twenty-four years, and caused by the retention of a piece of sponge in the vagina; the measurements of the sponge, removed after death, were three and a half by two inches.

The offensive discharge, hemorrhage, pain, and emaciation observed, in many cases lead to the suspicion, or even to the diagnosis, of malignant disease. Capuron[2] has narrated a case in which such a diagnosis was made for these reasons, but in which upon examination he found a sponge in the vagina. Breisky[3] has given a similar case as occurring in an unmarried woman; although no confession was got from her, Breisky believed that the sponge had been introduced to prevent conception, and had been forgotten. Never-

[1] British Medical Journal, 1882.

[2] Bibliothèque du Médecin-Praticien, tome i.

[3] Billroth, Handbuch der Frauenkrankheiten.

theless, Levrat[1] says that he has removed a sponge which had been in the vagina twenty-three years, and had only then begun to cause injurious results.

The foreign body, remaining in the vagina, may become encrusted by a mineral deposit, forming the so-called vaginal stone. This deposit is composed of the triple phosphate and calcium salts. One of the most interesting specimens of such incrustation was presented, a few years ago, to the Philadelphia Pathological Society, by Dr. Getchell.[2] This calculus had been removed from the vagina of a girl nineteen years of age; it was three inches long, one inch and a quarter wide, and three-eighths of an inch in thickness, and had been formed about a hair-pin as a nucleus. In some cases granulations are abundantly developed around a foreign body—a Meigs's watch-spring pessary, for example—so that it is completely concealed. Ulceration of the vaginal walls may result from the pressure of the foreign body, so that finally a passage is worn through the anterior or the posterior wall, causing a vesico-vaginal or a recto-vaginal opening, or both.

In making the diagnosis of foreign body, it is well, as advised by Breisky, not to trust too much to the statements of the patient, but to carefully examine not only the vagina, but also the rectum and bladder. In the removal, if the patient be restless or the operation painful, an anæsthetic should be used. The means for removal will vary with the character, size, and form of the body, and with its accessibility. Injections through a speculum may be used to wash out small, round bodies, and worms or insects; flat bodies, such as fragments of a glass syringe, may be removed with the finger; large bodies with the polypus-forceps; and still larger, with the obstetric forceps. Where the vagina is small, and the foreign body smooth and round, the surgeon may adopt the plan of Meissner, who with the finger in the rectum removed a stone from the vagina of a child of two years. When granulations surround the foreign body, these must first be torn with the finger, or divided with knife or scissors. In some cases it is necessary to cut or otherwise lessen the size of the foreign body itself. Thus, in the case reported by Dupuytren, in which an ivory pessary worn for several years had perforated the bladder and the rectum, he found it necessary, by means of forceps constructed for the purpose, to break the instrument in the rectum and also in the vagina, one fragment being removed through the latter and the other through the former.

If the foreign body have its size greatly increased by mineral incrustations, it is advised to remove these first, since otherwise the rough, jagged surface may injure the vagina when extraction is done. Sabatier speaks of his fingers being wounded by the "asperities of saline incrustations," which had made the tumor "as rough as a rasp."

One of the most ingenious devices for the removal of fragments of glass was used many years ago by Dr. Levis, of Philadelphia. A woman had a broken glass pessary in the vagina, and the efforts that had been made to remove the pieces had only resulted in reducing them to smaller pieces, comminuting them in fact; a severe vaginitis—due chiefly to the fragments of glass, but in part probably to the attempts at extraction—was present when the patient came under Dr. Levis's care. He threw into the vagina by means of a syringe a mixture of plaster-of-Paris, and after two or three days removed the mass, the solidified mixture having fixed in it the various pieces of glass.

Whatever means, manual or instrumental, are used for the removal of foreign bodies from the vagina, it is well to be guided by the words which Blundell said could be usefully inscribed on one of the blades of the obstetric forceps: *Arte, non vi.*

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[1] Nouveau Dictionnaire de Médecine et de Chirurgie Pratique, tome xxxviii.

[2] Philadelphia Medical Times, 1873.

In all cases after the removal of the foreign body, if it has been in the vagina for any length of time, antiseptic injections should be used once or oftener each day until healing of the diseased or injured parts has taken place.[1]

Genital Atresia.

Genital atresia in the female may involve any part of the utero-vagino-vulvar canal, and it may be congenital or accidental; in the congenital variety there may be only a rudimentary vagina, or this organ may be absent. The necessary accidents in most cases resulting from this condition depend upon the presence and functional activity of the uterus and ovaries.

Vulvar Atresia.—About the sixth week of intra-uterine life, there appears at that part of the embryo to be occupied by the external sexual organs a swelling known as the genital eminence, and then two lateral folds called the genital folds; at the end of the second month, the lower portion of the genital eminence presents a furrow or fissure, known as the genital fissure, and by this depression of the integument a communication is made which connects the internal genital organs, the bladder, and the rectum, with the exterior. Should the genital furrow fail to appear, or be imperfect, there is complete atresia of the vulva and of the anus. This arrest of development is usually associated with other anomalies affecting internal organs, and conditions result which are, as a rule, incompatible with life. so that the question of operation rarely arises.

In addition to this congenital form of complete vulvar atresia, there are two forms of partial atresia, both of which are accidental. The first, that which is most frequently seen, is oftenest found in young infants, and consists in an adhesion of the opposite surfaces of the nymphæ; Puech considers its most frequent cause to be an affection analogous to the balanitis of male children. The second form is that which results from adherence of the labia majora. The most common causes are acridity of the urine and want of cleanliness. Rarer causes are injuries inflicted in attempts at rape, burns, and different forms of vulvitis, especially that which may occur in smallpox, or in puerperal septicæmia. Adhesion of the nymphæ can usually be remedied by simply stretching them apart; in cases that will not yield to this stretching by the fingers, a grooved director may be passed from above downwards behind the united parts, and then with scissors or bistoury the intervening tissue may be divided. Traction may be tried in a similar manner if the labia majora are adherent, but incision of the connecting tissue will be required in most cases. Care must be taken after the operation, in each of these varieties of partial atresia, to prevent the separated surfaces from reuniting.

Imperforate Hymen.—The simplest and most frequent form of vaginal atresia is that arising from imperforate hymen; the hymen belongs to the vagina rather than to the vulva, although some writers, Puech, for example, describe the condition of the hymen mentioned as a vulvar atresia.

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[1] In addition to the bibliography given by Breisky in Billroth's Handbuch, and that referred to in the text, the following references are offered: Hauff, Ueber Fremdkörper in der Vagina. Tübingen, 1878; Medico-Chirurgical Transactions, vol. xxxi; Casper-Liman, Handbuch, 1881; Wien. med. Presse, 1875; Medical Times and Gazette, 1863, 1874, 1880; Lancet, 1848, 1850, 1872; Schmidt's Jahrbucher, 1870 und 1875; Le Méd.-Praticien, 1882; New Orleans Medical and Surgical Journal, 1884; Bibliothèque du Médecin-Praticien; Sabatier, Médecine Operatoire. Paris, 1832; Archives de Tocologie, 1881; Centralblatt für Gynäkologie, 1879; Berlin. klin. Woch., 1875; Boston Medical Journal, 1837; Nashville Journal of Medicine and Surgery, 1858; Medical News, 1884; American Journal of Obstetrics, Jan. 1882 (supplement), and May, 1883.

It is rare that hymeneal atresia is discovered, or produces any serious accidents, before puberty, though in a few instances accumulation of mucus may cause its distention in the infant, requiring an incision; such cases have been observed by Godefroy,[1] Depaul, Blundell, and some others. A girl affected with imperforate hymen has at the age of puberty the characteristic changes of that period, save that the monthly flow does not appear; at more or less regular intervals efforts at menstruation recur, but they are fruitless. At first, when there has been for a time secretion without excretion, the product accumulates in the vagina, this collection of blood being known as *hæmatocolpos.* When the vagina is distended to its utmost, the uterus becomes enlarged and contains the fluid which escapes periodically from its mucous surface, this intra-uterine collection being known as *hæmatometra;* the oviducts too, in some cases, may become receptacles for the menstrual fluid, and then the uterus, greatly enlarged, and its walls thinned—in one case observed by Puech,[2] they were as thin as paper—forms a notable abdominal tumor, having on each side a projection formed by the corresponding distended oviduct. In most cases, however, the tumors found on the sides of the uterus are caused by tension of the broad ligaments. A fatal termination may result from peritonitis caused by the passage of blood from the abdominal opening of an oviduct into the peritoneal cavity, or a similar accident may follow rupture of a distended oviduct, or of the uterus. Such a termination, according to Bernutz, is rare before the second or third year after the beginning of the accidents in congenital occlusion. In exceptional cases, the uterus by violent contractions overcomes the resistance, and there is then a spontaneous cure.

Treatment.—Emmet advises free incision of the hymen, and thorough washing out of the uterine cavity; and, certainly, the uniform success which he has had by this method speaks strongly in its favor. On the other hand, Bernutz favors gradual evacuation of the fluid, and condemns the washing out of the uterus which Récamier had practised. If the uterus be greatly distended, if the oviducts be also involved, or if adhesions have followed inflammation, most operators prefer gradual antiseptic drainage to rapid emptying of the uterus. In some cases[3] there may be one or more membranes above the hymen, obstructing the vagina, these being most frequently found at or a little above the middle of the canal; in one instance three, and in another four, were present, though in most cases there is only one; their treatment does not differ from that of imperforate hymen.

A vaginal atresia is called *complicated* when there is atresia of the uterus also; the treatment of the latter condition will be considered in connection with the next topic.

ABSENCE OR RUDIMENTARY CONDITION OF THE VAGINA.—When there is absence or a rudimentary condition of the vagina, a similar anomaly is in most cases found on the part of the uterus. In the one case there is interposed between the bladder and the rectum a thin layer of connective tissue; in the other there is a fibrous cord occupying the normal place of the vagina. In some instances this fibrous tissue may be partially converted into a canal, oftener at the upper than at the lower portion, but in some cases at both upper and lower—a *cul-de-sac* at each place—the intervening part being solid.

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[1] Bouchut, Traité Pratique des Maladies des Nouveau-nés.

[2] De l'Atrésie des Voies Génitales de la Femme.

[3] Delaunay, Étude sur le Cloisonnement transversal du Vagin complet et incomplet, d'origine congénitale. Paris, 1877.

The question as to an operation for the formation of a vagina, in such a subject, is by the majority of surgeons decided in the negative. Ashhurst,[1] for example, referring to the matter, observes that the surgeon's art may enable such a woman to be a man's mistress, but can never fit her to be his wife and the mother of his children. The late Dr. Gross said, "nothing is to be done . . . . the woman is impotent, and therefore disqualified for marriage." Roubaud[2] says that "the surgeon ought never to compromise his art by facilitating a coitus of which the final end, fecundation, cannot be attained." Puech also rejects the operation in cases of rudimentary uterus, or of absence of this organ.

Levrat, on the other hand, admitting that such an operation is only for the purpose of rendering coition possible,[3] calls it "an operation of complaisance," but adds that, "as Le Fort says, these operations of complaisance may, after marriage, become operations of necessity."

Dr. Emmet holds that "if the vagina be absent, it is proper to open a canal at an early age, even if no retention exists, if a vestige of the uterus can be detected;" he says that in one of the cases operated on by him, "nature had evidently delayed the development of puberty in consequence of an occlusion," while in another the uterus was developed after failure of the operation to discover any trace of the organ.

There is no difference of opinion as to the propriety of attempting the formation of a vagina if the uterus is present, and especially if it is enlarged by the accumulation of menstrual fluid; the procedure is facilitated by the latter condition. In performing the operation, the patient is anæsthetized and placed in the lithotomy position; the operator passes into the bladder a steel sound or catheter, which is held by an assistant, and then introduces the index finger of the left hand into the rectum. The next step is to cut the skin, by snipping with scissors in a vertical line below the urethra (Emmet), or by a transverse or slightly curved incision, with its concavity above, and equidistant from the rectum and the urethra (L. de Sinéty); then a finger of the right hand is used to press and to tear the tissues apart, as originally advised and practised by Amussat. While Amussat made the new vagina by successive stages, most operators prefer with Emmet to accomplish this at a single sitting. In rare cases the handle of the scalpel may be used in this process of tearing, if the tissues resist the finger too strongly, or they may be snipped by the scissors. In a very interesting case narrated by Fletcher,[4] of a married woman twenty-two years old, who suffered from absence of the vagina, he made a dissection with the scalpel two inches in depth, and then successfully completed the opening of a passage to the uterus by means of a large rectal bougie, which, introduced into the opening made by the scalpel, was forced farther by successive blows with a mallet upon its external end. The operator in the process of tearing, or of dissection, guards against injury to the bladder or the rectum by the finger in the latter, and by the sound in the former. If, after reaching the neck of the womb, it be found imperforate, a trocar, a suitable knife, or scissors, may be used to open it. In addition to the dangers of the operation which have been mentioned, the ureters or the peritoneum may be injured. "Some surgeons,[5] even the most able, have been under the necessity of desisting from the operation, because it has appeared to them impracticable or too dangerous."

In cases where it has been difficult or impossible, by the creation of a vagina or the restoration of the organ after accidental occlusion, to get access to the womb distended by menstrual fluid, puncture of the uterus through the rectum has been successfully resorted to. Such a puncture, if a small trocar is used, is not dangerous. Simon proposed as a substitute for this operation, an opening into the uterus through the bladder.

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[1] Principles and Practice of Surgery.

[2] Traité de l'Impuissance et de la Stérilité.

[3] Nouveau Dictionnaire de Médecine et de Chir. Prat., tome xxxviii.

[4] Medico-Chirurgical Notes and Illustrations. London, 1831.

[5] Hegar und Kaltenbach, op. cit.

COMPLEX ATRESIA.—In some cases of double uterus and vagina, one of the vaginas or one of the uteruses may be occluded ; such an occlusion is called a complex atresia. If the vagina be only occluded in part, menstrual blood accumulates in the unobstructed portion, giving rise to a tumor which encroaches upon the open vagina, and this tumor is known as *lateral hæmatocolpos.* After a time the uterus itself becomes distended, and then there is *lateral hæmatometra* conjoined with hæmatocolpos. If the vagina is completely occluded, or the os uteri closed, the menstrual fluid is confined to the uterus. In case of lateral hæmatocolpos, an opening may be readily made from the other vagina. So too, in lateral hæmatometra, an opening may be made from the vagina belonging to the other uterus, or from the cervical canal of the latter.

ACCIDENTAL GENITAL ATRESIA.—It is altogether exceptional for this form of atresia to occur prior to the establishment of the menstrual function, but when it does occur, the effects are the same as in the congenital form, and therefore such cases may be omitted from present consideration. Accidental or acquired atresia may result from cauterization, from amputation or cancer of the neck of the womb; from irritant or corrosive substances introduced into the vagina—as in the case of a woman who used a vaginal injection of sulphuric acid to procure abortion—from puerperal vaginitis, from ulceration of the vagina in typhoid fever or in smallpox, etc.

The accidents characterizing menstrual retention from accidental atresia are similar to those observed in congenital atresia. They differ, as pointed out by Bernutz, in the much greater gravity which they present ; and there will be symptoms produced at the first attack of pain, which are not usually found until the fifth or sixth month in cases of congenital retention. "At the second or third menstrual epoch without excretion, this depending upon the habitual abundance of the flow and upon circumstances which may increase or lessen the secretion, the patients are a prey to cruel uterine colics, which usually compel them to seek professional help." At this time an abdominal tumor may be found, caused by the enlarged uterus, and also a vaginal tumor if there be space above the adherent part of the vagina for the collection of blood. The prognosis is the more favorable, in this as well as in congenital atresia, the shorter the time that menstrual retention has existed.

Treatment.—This does not differ from that required in the corresponding form of congenital atresia, save that, if the atresia be of the vagina, it will be found necessary, on account of the firm and resisting character of the cicatricial tissue, to resort more frequently to bistoury or scissors. Most surgeons prefer operating at a time when the sexual organs are in repose, therefore about the middle of the menstrual interval. The local use of antiseptics is to be observed in the operation and in the after-treatment. Another important prophylactic means is to keep the patient in bed, even after apparently so simple an operation as opening an imperforate hymen, for some days subsequently. The liability to contraction and closure of the vagina which has been formed, or of that which has been opened, should be guarded against by the regular introduction of some artificial dilating body, such as a uterine glass speculum, or one of Sims's dilators.

DOUBLE VAGINA.

Duplicity of the vagina is caused by an arrest of development; coalescence of the lower portions of Müller's ducts has occurred, but absorption of the intervening double wall has failed. In the majority of cases a similar arrest of development has affected the uterus, so that it also is double. Nevertheless, in several cases[1] that have been observed the uterus has been single, though in some of these[2] the os and cervix have been double. Usually the two vaginas are placed side by side, not, however, precisely parallel, but the left on a plane a little anterior to the right. Dempsey[3] has reported a case in which the septum was transverse, one vagina thus being anterior, and the other posterior. In Stickel's[4] case, menstruation occurred alternately through one and the other vagina, but never simultaneously through both. It not unfrequently happens that one vagina is larger than the other; and in one case[5] at least in which two uteruses existed, these organs corresponded in size with the respective vaginas. In a case reported by Ollivier,[6] upon post-mortem examination of a woman, forty-two years of age, who had given birth to six children, there were found two uteruses and two vaginas, and only the left uterus had been pregnant; as far as the right vagina was concerned, the woman had remained a virgin. In another instance[7] each uterus, in a woman who had previously given birth to three children, was pregnant, and aborted—a one month's fœtus being removed from one uterus, and three days afterwards a three months' fœtus from the other. In one case[8] of single uterus with two vaginas, only one of these communicated with the womb, the other, though of about equal length, being simply a *cul-de-sac*. In most of the cases in which the thickness of the septum has been mentioned, this was about one-eighth of an inch. Many of the cases of duplicity of the vagina have been first recognized in labor, and in the majority of these the septum has been spontaneously torn; in others it has caused such delay in labor that it has been divided by the obstetrician. In other instances, painful coition has led to the discovery of the malformation. In one instance each vagina was too small for intromission, and coitus had for some years been practised through the urethra.

The *treatment* of double vagina is division of the septum with scissors, if the difficulty be first discovered when the subject is in labor; under other circumstances this division may be made with the galvano-cautery wire, or with the elastic ligature.

HYDROCELE MULIEBRIS.

The peritoneal covering of the round ligament normally ends at the inguinal canal, but in some cases it is prolonged to the labium majus, causing a persistence of the canal of Nuck. This canal may have free communication with the peritoneal cavity, or it may be closed at the abdominal ring; in the latter case a cyst is formed, encysted hydrocele. In rare cases the cyst is double, the canal not only being closed at the abdominal ring, but also at some other point in its course. In some instances the cyst is in the round ligament,[1] its fibres being separated. In a third condition fluid may collect outside of the canal. Cases of hydrocele of the femoral canal, much rarer than those of the canal of Nuck, have also been observed.

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[1] Schmidt's Jahrbucher, 1870; Boston Medical and Surgical Journal, 1882; Edinburgh Medical Journal, 1864; Matthews Duncan, Researches in Obstetrics (two cases).

[2] For example, in Dempsey's case (Dublin Journal of Medical Sciences, vol. lxvi.).

[3] Op. cit.

[4] Boston Med. and Surg. Journal, 1859.

[5] Arch. für Gynäkol., 1884.

[6] Gaz. Méd. de Paris, 1872.

[7] Chicago Med. Jour., 1879.

[8] Boardman's case (Boston Medical and Surgical Journal, 1882). A somewhat similar case has been observed by Emmet (Principles and Practice of Gynæcology).

The tumor formed by hydrocele is usually about the size of a hen's egg; its contents are generally serous and transparent, but may be greenish in color. No impulse is communicated to the tumor by coughing, and fluctuation may generally be recognized; the most important diagnostic mark is translucency by transmitted light, and in this examination Osborn[2] recommends using the ordinary stethoscope.

Chiari has given examples of inflamed hydrocele, a disorder which may be confounded with inflamed epiplocele or strangulated hernia; in one of two cases observed by Wile,[3] inflammation and suppuration occurred. The disease is not frequently seen. Hennig,[4] in a recent paper, said that he was able to find only thirty-nine cases reported.

Treatment.—Hennig, in 1868, successfully treated a case of hydrocele by free incision, then passing into the sac a double iron-wire suture. Bennet, in 1870,[5] succeeded by first evacuating the cyst and then injecting a saturated solution of iodine. Wile removed the fluid with the fine needle of an aspirator, and injected half a drachm of tincture of iodine. Goodell suggests that if there is any communication with the abdominal cavity, pressure should be made at the internal ring, and the injected fluid should be withdrawn. Osborn succeeded by simple tapping, followed by manipulation so that the walls of the cyst would become inflamed, then applying ice and keeping the patient at rest. Hegar and Kaltenbach advise free incision and keeping the wound open by stitching the margins of the incised cyst and skin together.

Vulvar and Vaginal Fissures.

Occasionally, especially in women recently married, one or more fissures may be found at the vulva or just at the entrance of the vagina. Analogous to anal fissure, these may cause great distress, especially in coition, in some cases indeed resulting in vaginismus. The *treatment* required by a vulvar or vaginal fissure is, in the first place, physiological rest of the parts. Next, the application of iodoform in powder twice a day; and, if this should fail in curing, dilatation of the vaginal entrance, or a longitudinal incision through the base of the fissure.

Noma Pudendi.

Gangrene of the vulva may result from traumatism, as by a blow or fall, or by injury in labor; it may follow the punctures of anasarca, or may occur in typhoid or in puerperal fever. The disease, however, is more frequent in infancy than at any other period of life, and is then usually called *noma*, being regarded as analogous to cancrum oris. According to Parrot,[6] it is in the beginning simply aphthous vulvitis, the gangrene not being a complication but a modality of this vulvitis. The disease first appears in the form of vesicles, or phlyctenulæ, filled with a sanguinolent fluid, and having a grayish or brownish tint. These are soon replaced by black patches, while the surrounding parts are swollen and œdematous. The labia majora are affected twice as often as any other part of the vulva; the disease may extend to the genito-crural folds, groins, perineum, anus, rectum, neighboring parts of the thighs, and mons veneris. In thirty-nine out of fifty-six cases mentioned by Parrot, the disease occurred in connection with measles, while in only nine was it independent of any other affection. Purefoy[1] says that there is a febrile condition which lasts about three days before the local manifestation of the disease. Madden[2] says that it is most frequent in the scrofulous and half-starved children of the poor. While improvement of nutrition and the administration of tonics are indicated, the local treatment is more important. Black wash, Condy's fluid, a solution of carbolic acid, etc., are recommended by some surgeons; Parrot advises simply the employment of iodoform. This should be freely applied in the form of powder once a day to the diseased parts; the result is very prompt and satisfactory.

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[1] Hegar und Kaltenbach, op. cit.

[2] Lancet, March 7, 1885.

[3] American Journal of Obstetrics.

[4] Centralblatt für Gynäkologie.

[5] Medical Record, 1870.

[6] Revue de Médecine, 1881.

LUPUS.

Huguier, in 1848, described under the name of *esthiomène*, an affection of the vulva which most authors regard as lupus, analogous to the disease as it appears on the face. He made different varieties, *superficial*, *deep*, and *hypertrophic*. According to Deschamps,[3] under the name of esthiomène of the vulva, affections the most diverse from an anatomical point of view have been described—epithelioma, syphilis, tuberculosis, elephantiasis, etc.—and therefore the term should be rejected. He even regards it as possible that the name of lupus will also disappear when it can be conclusively shown that the affection so designated is of a tuberculous nature.

Lupus of the vulva has not been often observed, though possibly the disease is less infrequent than is generally supposed. Huguier reported nine cases, West[4] five, Taylor[5] six, Macdonald[6] three, and Matthews Duncan[7] four. Of these twenty-seven patients the youngest was thirteen, and the oldest fifty-seven years old.

According to Taylor, when lupus presents the *superficial* or *serpiginous* form, the labia majora are generally affected first, or the crease between one of them and the thigh. Cutaneous tubercles are gradually developed; these vary in size, and in some cases are united at their borders so as to form masses which in their central part present ulcerations notable for their irregular borders, and hence called serpiginous ulcerations. The disease may involve the entire vulva, and may extend to the groins, to the perineum, and to the anal region. The ulcerated parts present a whitish or violet color. One part may be healing while the disease is invading another, and afterward that which has been healed may be again affected. If the ulceration be *deep* instead of superficial, perforation may take place into the bladder or into the rectum, or the ulceration may dissect away the cellular tissue around the latter, causing the organ to protrude for several inches. In the *hypertrophic* form, the nymphæ and the hood of the clitoris are most frequently affected, although the disease may extend to the entire vulva; the diseased parts may be increased to four or five times their natural size. The secretion from ulcerated lupus is usually slight, not purulent, but serous; in some cases, however, a dirty, puriform discharge has been observed, and Duncan has called attention to lupus of the vulva especially characterized by bleeding.

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[1] American Journal of Obstetrics, October, 1882.

[2] Ibid.

[3] Archives de Tocologie, Mars, 1885.

[4] Diseases of Women.

[5] Transactions of the American Gynæcological Society, vol. vi.

[6] Transactions of the Edinburgh Obstetrical Society, vol. ix.

[7] Ibid.

The disease is essentially chronic, lasting for many years; when death results, it is usually from peritonitis. According to the statistics presented by Taylor, treatment relieves more cases than it cures, but more cases are cured than entirely unrelieved. The patients do not suffer severe pain, but in the hypertrophic variety of the disease have great discomfort and difficulty in walking, and coition may be likewise interfered with; such a result, too, follows healing of ulcerated surfaces at or near the vulvar opening, which is narrowed by the resulting cicatrices.

Treatment.—Most authorities attach little importance to constitutional remedies. Taylor uses few: he chiefly trusts to the bichloride of mercury in doses of one-twenty-fifth of a grain, in a tonic mixture. L. de Sinéty advises suitable hygiene and the administration of cod-liver oil and the potassic or ferric iodide, the two last-mentioned remedies being used separately; he also advises the employment of tincture of iodine, and he speaks favorably of sulphur waters and sea-bathing. The *local treatment* is of the first importance. In the serpiginous form of ulceration, cauterization is advised. Taylor recommends the acid nitrate of mercury; Martin,[1] strong nitric acid; Guérin,[2] Vienna, arsenical, or chloride-of-zinc paste, preferring the last; L. de Sinéty,[3] caustic potassa; the galvano-cautery and the thermo-cautery have been advised by others. In deep ulceration caustics cannot be used; but here the parts may be brushed with tincture of iodine, and iodoform may be applied in powder. In the hypertrophic form (*esthiomène éléphantiasic*, *lupus prominens*) excision is usually resorted to. This has been done with the galvano-cautery, with Taylor's crushing scissors, and with Chéron's instrument—*forcipresseur à lames parallèles*—used to first pedunculize the tumors, after which they are cut off. The method of erasion, or scraping, as used by Volkmann in lupus of the face, has also been applied to vulvar lupus.[4] A small, long spoon, with moderately sharp edges, has been devised for the purpose of scraping away the hypertrophied tissues. This scraping must be very complete; after the hemorrhage has ceased, the solid nitrate of silver is freely applied, and then the parts are dressed with lint dipped in carbolized oil; an anæsthetic is advisable during the processes of erasion and cauterization.

ELEPHANTIASIS OF THE VULVA.

Elephantiasis affects the external genital organs next in frequency to the leg and foot. The disease is not of frequent occurrence except in tropical and semitropical countries. The first case of vulvar elephantiasis[5] clearly described, was observed by Saucerotte in 1776. The disease may occupy the entire vulva, or may be limited to a particular part, as, for example, the clitoris. In the majority of cases it is found affecting one or both labia majora, either with or without other parts being involved. Mayer's[6] statistics, which include thirty-seven cases, show that the disease began in eighteen during the period between twenty and thirty years of age.

Elephantiasis usually appears in the form of broad-based tumors, but they may be pedunculated. These tumors frequently grow to an enormous size; one may be as large as the head of an adult, and weigh from twenty to thirty pounds. Barron Larrey[7] saw in Egypt a woman who had elephantiasis of the feet, and also of the vulva; the disease of the latter appeared as two tumors, one on either side of the vulva, each being as large as an infant's head, and measuring more than thirteen inches in circumference, four inches in transverse diameter, and seven inches in height. The tumors of elephantiasis temporarily increase in size during menstruation, and in pregnancy.

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[1] Billroth, Handbuch der Frauenkrankheiten.

[2] Maladies des Organes Génitaux Externes de la Femme.

[3] Traité Pratique de Gynécologie.

[4] Stowers, British Medical Journal, January 3, 1885.

[5] Cellard, De l'Éléphantiasis Vulvaire chez les Européennes. 1877.

[6] Die Elephantiasis Vulvæ.

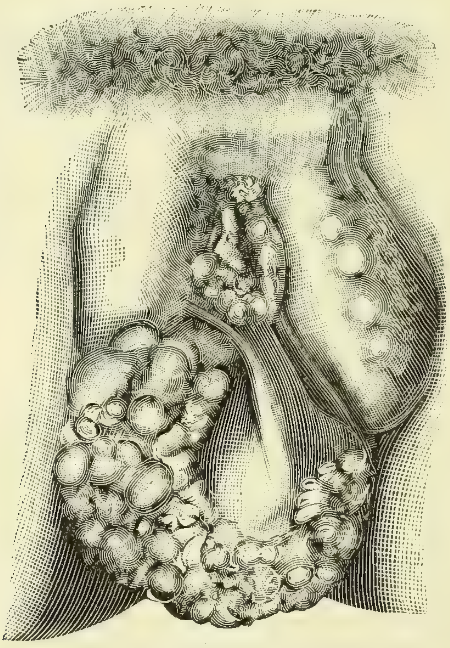
[7] Relation historique et chirurgicale de l'Expédition de l'armée d'Orient en Égypte et en Syrie.

In some cases the origin of the disease may be traced to an injury, while in others it has been attributed to eczema, erysipelas, or syphilis. The skin is greatly thickened, and abundant proliferation of its constituents occurs, while the lymph-spaces and lymph-vessels are greatly dilated.

Elephantiasis may be confounded with condylomata, or with lupus. From the former, it is distinguished by there being present changes in the tissues beneath the tumors, in elephantiasis; from the latter, by the ulceration in elephantiasis being superficial and healing spontaneously, while those of lupus are deeper and progressive.

Medical *treatment* is without avail, and the only remedy is extirpation of the diseased mass. If this be pedunculated, a double ligature may be applied, and then excision effected with scissors or knife. When the growth has a broad base, the thermo-cautery, the galvano-cautery,[1] the écraseur, the elastic ligature, scissors, or the scalpel, may be used. If the form of the tumor permit, the method of McGregor[2] may be followed; he applied Esmarch's bandage, so that the operation was made almost bloodless, though the tumor was a very large one, and though twenty vessels were tied. If the tumor be removed by the knife, bleeding vessels should be tied at once, or hæmo-

Fig. 1399.



Elephantiasis of the vulva. (After Schroeder.)

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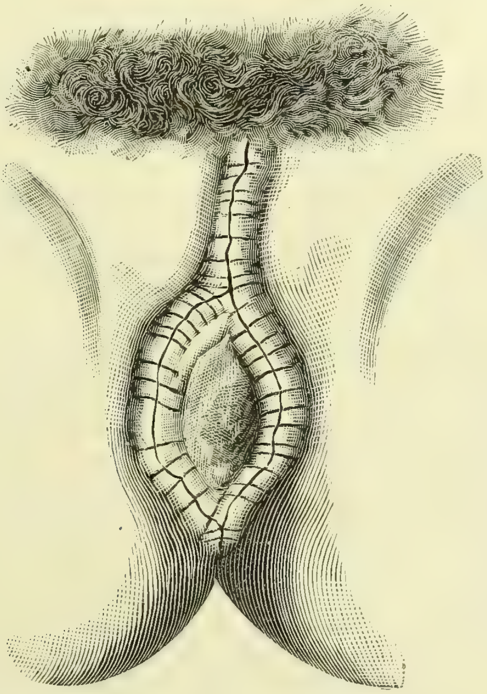
[1] In Bourguet's case (Gazette des Hôpitaux, 1867), operated on with the écraseur, the bladder was injured, and death from peritonitis occurred on the third day.

[2] Glasgow Medical Journal, 1879.

static forceps used; or the plan of Schroeder,[1] or that of Mundé,[2] may be followed. Schroeder begins cutting away the growth at its lowest part, and at once stitches the borders of the incision together, and thus proceeds step by step, to the upper part, immediate union of the wound by deep stitches following the process of excision. The following illustrations show, first, the mass to be removed (Fig. 1399), and then the united wound after the removal (Fig. 1400). Mundé resorted to the ingenious method of passing under the base of the tumor three strong pins, and beneath their projecting ends an elastic ligature, thus pedunculating the tumor; the tumor was then excised without loss of blood, though after the removal of the pins and ligature several vessels had to be tied.

Fig. 1400.



Operation for elephantiasis of vulva. (After Mundé.)

In some cases the disease returns, and in rare instances the operation is followed by death; this event occurred in only one of forty cases analyzed by Cellard.

TUMORS OF THE VULVA.

CYSTS.—Most vulvar cysts originate from the vulvo-vaginal glands[3] or from their excretory ducts, and are retention-cysts. They occur much more frequently upon the left than upon the right side—in eighteen cases out of thirty-four observed by Huguier, in eight out of nine under the care of Emmet. If the tumor has its origin in the duct, and this is much the more frequent variety, it is unilocular, but it is multilocular if arising from the gland. The contents are usually serous and translucent, but may be jelly-like and chocolate-colored, or simply fluid blood; a case of this kind, originally regarded as an abscess of the vulvo-vaginal gland, but afterward called a labial thrombus, was observed by Dr. Storer,[1] but it was not an effusion of blood into the connective tissue, and therefore did not answer to the ordinary definition of a labial thrombus or hæmatoma.

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[1] Zeitschrift für Geburtshülfe und Gynäkologie, 1878.
[2] American Journal of Obstetrics, volume xv.
[3] This seems to be doubted by Matthews Duncan (Medical Times and Gazette, vol. i. 1880).

The size of these cysts varies; rarely greater than that of a walnut or a hen's egg, it may be as large as that of a goose's egg, an orange, or, according to Hildebrandt, a child's head at birth. If the tumor be small, it will appear solid, and it is then only by the exploring needle or aspirator that a correct diagnosis can be made.

In the *treatment* of these tumors, simple evacuation of the contents affords only temporary benefit, for, the cyst-wall remaining entire and unchanged, the tumor re-forms. Another method consists in the use of a seton, and the results have been favorable. The cyst has been freely opened, and the cyst-wall cauterized with iodine, with nitrate of silver, or with the thermo-cautery; the result is usually satisfactory. The cyst may be extirpated; in this operation great care must be taken in cutting the tissues over the cyst, to avoid opening it, and after the first incision the removal of the tumor should be accomplished chiefly with the handle of the scalpel. If complete removal of the cyst prove difficult or impossible, a part of its wall may be excised, and the remaining cavity may be filled with oakum or carbolized cotton.

Rarer cysts have been attributed to clots of blood which have been encapsulated, or to ectasia of lymphatic vessels. Werth[2] has described a cyst the size of a cherry, observed by him in a girl twenty years old, which had not the complicated and typical structure of a retention-cyst, but which originated from a displaced mass of epithelium.

Sebaceous cysts have been frequently met with in the vulva; though small, they cause considerable annoyance. Dermoid cysts have been rarely seen in this part. Cysts of the nymphæ are very rare; Dr. Wiltshire[3] has described two observed by him in different subjects, one tumor the size of a hazel-nut, the other as large as a walnut; they were attached in a slightly pendulous manner, and contained a translucent fluid. Bartelberger[4] has recently described a cyst the size of a lentil, found by him in the hymen of a new-born child, the cyst being microscopically analogous to retention-cysts of the nymphæ. Dr. Lusk[5] met with a gaseous tumor of the labium, originating, as he believed, in an abscess of Bartholin's gland that had opened into the rectum, and had left a fistula connecting the gland and the bowel.

Lipomata.—Lipomata generally originate from one or the other of the labia majora, or from the mons veneris. Like fibro-myomata they are movable, but they differ from the latter in consistence; this mobility assists in distinguishing them from the tumors of elephantiasis. In some cases a lipoma attains an enormous size, as in those reported by Stiegle[6] and by Capelle.[7] In the former case the tumor, originating from the left labium majus, was fifty-five centimetres long, fifteen broad, and thirteen thick, and it weighed ten pounds. Capelle's patient was thirty years old, had been married ten years, and had observed for this time an increase in the right labium majus, until, in May, 1859, it was found that a lipoma occupied the space from the pubic symphysis to the buttocks, and reached to the knees; the tumor was thirty-three centimetres in length and fifty in circumference; it was successfully removed.

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[1] Journal of the Gynæcological Society of Boston, vol. ii.

[2] Centralblatt für Gynäkologie, 1878.

[3] Trans. Obstet. Soc. Lond., vol. xxiii.

[4] Archiv für Gynäkologie, 1884.

[5] American Journal of Obstetrics, vol. xiii.

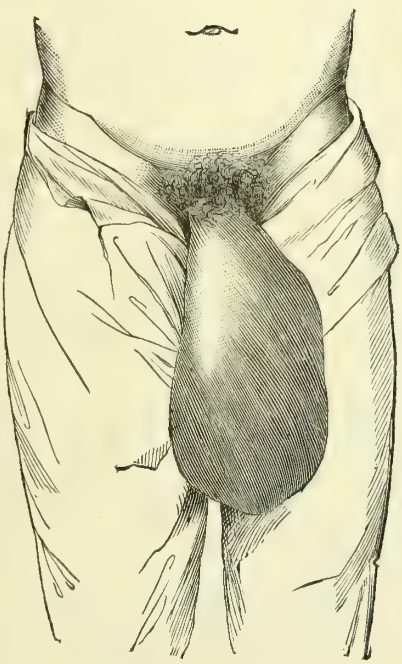
[6] Zeitschrift für Chirurgie und Geburtshülfe, 1856.

[7] Journ. de Méd., etc. Bruxelles, 1860.

Bruntzel[1] has narrated a case of labor complicated by a lipoma of the right labium majus the size of a man's fist; it had been first noticed four years before; a folded towel was used to draw the growth to one side, and the forceps was successfully used without injury to either the perineum or the tumor.

Fibromata.—Solid tumors—fibrous, myomatous, or fibro-myomatous—may occur at the vulva. According to Hildebrandt they are formed from the subcutaneous connective tissue of the perineum and of the labia majora, and from the muscular fibres of the round ligament. A fibrous growth may be formed on one of the nymphæ, as in a case reported by the late Dr. George Pepper.[2] The size of these tumors varies from that of a pea to that of the fist, or may even be much larger, as in a case observed by Schroeder, in which the tumor was as large as a child's head, or as in that of Hill,[3] in which it measured eleven inches in length and twenty in circumference, and after removal weighed nearly three pounds and a half. These tumors frequently increase in size during menstruation or pregnancy, diminishing somewhat in the absence of these conditions. Tending to grow in the direction of least resistance, it is not unusual for a fibroma to become pedunculated, and the tumor, increasing in weight, may elongate the pedicle, so that the growth may fall as low as the knees. The removal of lipomata or fibromata is effected by dividing the pedicle, if the tumor have become polypoid; by enucleation, if it be attached by a broad base.

Fig. 1401.



Fibroid of labium majus. (After Storer.)

An instructive case has been recorded[4] in which extirpation of a solid tumor which had been observed for ten years in the left labium majus of a girl eleven years old, proved the tumor to be the ovary; the patient died of peritonitis.

Warty Tumors or Vegetations of the Vulva.—Papillary hypertrophy may occur at different points of the vulva, causing tumors varying in size, in form, and in number. They may be sessile, or pedunculated; separate, or united in a single mass—in the latter case resembling a cauliflower; their summits may be serrated—the cock's-comb form—or irregularly rounded, or the tumors may present a raspberry-like appearance. Their color varies from a pinkish-white to deep red, or even violet, when they may be turgid, and may resemble erectile tumors. They may be small and few, or large and many, and a great number may be united so as to make a mass the size of a child's head[1] or of that of an adult.[2] They are found upon the nymphæ, upon the clitoris and its hood, at the orifice of the urethra, upon the vestibule, upon the labia majora and the adjoining skin, and at the anus. They become much larger during a menstrual period, and especially during pregnancy, often disappearing after labor. They have been observed in children; Dr. Walter G. Smith[3] has reported their occurrence in two sisters, one four, the other fourteen years of age, and in neither was there any evidence of syphilis.

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[1] Centralblatt für Gynäkologie, 1882.

[2] American Journal of Obstetrics, vol. iii.

[3] Indian Medical Gazette, 1882.

[4] Gazette des Hôpitaux, 1851.

When the growths are large, the patient finds it difficult to walk or even to sit; the only tolerable position is lying on the back with the lower limbs flexed. They give rise to a discharge, which in some cases has a most offensive odor.

While in the majority of cases these growths have a venereal origin, in many other instances they cannot be thus explained. Kühn says that it is possible that vegetations may originate in a simple inflammation of the vulva and vagina, if these are mechanically irritated. A conclusive argument against the syphilitic character of these growths, is the fact that they may occur in pregnant women who are entirely free from venereal disease, and spontaneously disappear when the pregnancy has ended. The most different irritating causes produce this local accident, which always remains a manifestation limited to the point of its development, and which does not denote constitutional contamination. While usually papillomata are not in themselves sensitive, but cause pain from their attachment, yet in some cases not only are the papillæ developed, but the subjacent connective tissue also, with its nerves and vessels, enters into the structure of these growths, and then they are very sensitive.

The *treatment* consists in excision, or in cauterization. The former is suitable for the vegetations when few and pedunculated; curved scissors may be used, and the wound may be touched with a solution of perchloride of iron, or with a stick of nitrate of silver. If the growths are extensive, an anæsthetic should be used, and then they may be destroyed by the thermo-cautery, the galvano-cautery, or by crystallizable acetic acid, hydrochloric acid, or nitric acid; chromic acid is rejected because of its producing so much pain. In case of very large tumors, removal with the écraseur or the galvano-cautery wire is necessary. Where there is great tendency to the reappearance of the vegetations, L. de Sinéty advises daily painting the surface where they are seen to show themselves with a saturated solution of picric acid.

When these vegetations occur in pregnancy, it is not generally advisable to operate on them, as they usually disappear after confinement, and as their removal is attended with considerable bleeding. Charpentier refers to two cases of pregnant women in whom the growths were as large as apples; by simply isolating the affected surfaces and applying compresses dipped in Labarraque's solution, the tumors disappeared before the end of gestation.[4]

HÆMATOMA.—By hæmatoma or thrombus of the vulva, is meant a collection of blood in the vulvar connective tissue. This collection usually occupies one of the labia majora—rarely both—or the nymphæ; it may extend to the perineum, or a hæmatoma of the vagina may involve a part of the vulva. The hemorrhage generally is venous, though it is not impossible that in some cases it may be arterial. A varicose condition of the vulvar veins creates a predisposition to the accident, but is not essential for its occurrence. Labor is the determining cause of vulvar hæmatoma in the majority of cases, the effusion of blood occurring during or immediately after labor, or in childbed; the former is the more frequent. Nevertheless, it may happen in pregnancy, or independently of this condition; in the latter case the accident has resulted from a fall, a blow, or simply from a violent muscular effort. The tumor varies in size from that of a pullet's egg to that of a child's head.

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[1] British Medical Journal, 1865. In this case, observed at the Hull General Hospital and occurring in a girl twenty-one years old, the tumor was removed with knife, écraseur, and ligature.

[2] Med. Times, 1872.

[3] Dublin Journal of Medical Science, volume lxix.

[4] Guérin, op. cit.; L. de Sinéty, op. cit.; Breisky, op. cit.; Charpentier, Traité Pratique des Accouchements. Paris, 1883.

The *symptoms* are the abrupt appearance at the vulva of a bluish tumor, which increases in size more or less rapidly; the tumor is fluctuating, doughy, or hard, according to the condition of the blood, the size of the swelling, its duration, and the changes that have occurred in its contents. Usually the blood-cavity is single, but Canivet[1] has given an instance in which it was multiple: A girl twenty-six years of age had, two years before, received a kick upon the vulva, the injury affecting chiefly the left labium majus, which from that time was larger than the right. Upon examination, the affected labium contained a tumor the size of a pullet's egg; the tumor was extirpated, and it was found to have numerous septa, each containing a thick, chocolate-colored liquid, which was evidently altered blood; the tumor weighed fifty grammes.

Absorption generally occurs if the hæmatoma is small; but if it is large, rupture may happen with immediate danger to life, or the tissues surrounding it may be so compressed that gangrene will result, and as consequences secondary hemorrhage and liability to septicæmia. If the tumor is no larger than the fist, or an apple, absorption usually occurs; middle-sized tumors also are usually absorbed, but the time required is long, and in some cases inflammation and abscess follow.

Treatment.—Rest is the most important therapeutic means in all cases, and is all that is required if the tumor is small; if large and increasing, cold and compression may be used. If there is danger of rupture of the skin, that accident is to be anticipated by making an incision, but the longer that this incision can be delayed after the formation of the tumor—three or four days, for example—the better. If the tumor, occurring in labor, be so large as to prevent the delivery of the child, it must be opened, emptied, and a cotton tampon dipped in some astringent solution firmly applied. In all cases in which an opening is made, or occurs spontaneously, local antiseptic treatment should be carefully enforced.

CANCER OF THE VULVA.—Cancer of the vulva is a rare affection, forming, according to Gönner's statistics, one in twenty of all cases of cancer of the female genital organs; one in forty, as compared with those primarily developed in the uterus, according to the statement of Virchow, Mayer, and d'Espine. In the great majority of cases the epitheliomatous variety of the disease is found, though the others, including the melanotic, may occur; a case of melanotic tumor of the vulva is reported by Bailly[2] from Demarquay's clinique. Most of the patients are over fifty years of age; one of McClintock's, however, was forty-eight; one of West's thirty-four, and another thirty-one; and one of Küstner's thirty-four. In one of Gönner's patients the disease appeared during pregnancy. The disease usually begins at the external surface of one of the labia majora, exceptionally in the nymphæ or clitoris. A little hard tubercle is in most cases first observed, at or near the edge of the labium, and, without being the seat of positive pain, is generally a source of annoyance from the itching and smarting which it occasions (West). West thinks that the disease may remain in this condition for several months, or even longer, before ulceration of the tubercle, followed by extension of the disease, occurs. After ulceration has begun, a fatal result may be expected within two years.

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[1] Bulletin de la Société Anatomique, 1875.

[2] Gazette Hebdom., 1868.

Prognosis and Treatment.—The prognosis after extirpation of the disease is favorable, if the neighboring lymphatics are not involved. Küstner[1] advises the removal of the diseased tissue by incising the skin outside of the swelling, then making a deep incision, and completing the extirpation from the inner side; the amount of hemorrhage need not create alarm, as the field of operation is superficial, and every artery can be easily ligated. He urges the removal of the lymphatic glands on the diseased side if they are larger than those on the sound side. This removal is to be done with a blunt instrument, to guard against injury to bloodvessels, and against the danger of inoculation. Gönner regards the galvano-caustic as preferable to the knife in most cases; if the tumor has a broad base, union by first intention is not to be expected, and the galvano-cautery protects against septic infection. When removal is not possible, the treatment is limited to the use of narcotics and of disinfectants, and to the local application of a solution of muriate of cocaine.

Vaginal Tumors.

Cystic Tumors.—Vaginal cysts are more frequent than has generally been supposed. They have been found[2] in 6 out of 36 cadavers examined for them. In many instances they are not recognized, because usually, unless large, they cause no inconvenience, and small ones are discovered only by accident; Graefe[3] says that the small ones are only accidentally discovered, and that the large ones are mistaken for incurable prolapse. They are found more frequently in adults than in the young, although Winckel and Breisky[4] have seen them in a new-born child, the tumor being of the size of a hazel-nut, and protruding from the hymeneal opening. Of 61 examples[5] of vaginal cyst, 29 belonged to the anterior wall of the vagina and 21 to the posterior, while only 11 were found in the lateral walls. They are found with equal frequency in the upper, middle, and lower thirds of the vagina; in this regard these formations have no place of predilection.

The size of vaginal cysts varies from that of a millet-seed to that of a hen's or a goose's egg; in some instances they are much larger than even the last, as in a case reported by Noyes,[6] in which a cyst of the anterior wall of the vagina, which had been growing for sixteen years, was the size of the two fists, or in that of Veit,[7] in which it was as large as a child's head. The tumor is usually single, but Kaltenbach[8] removed a large multiple cyst from the posterior wall of the vagina, and Channing met with a bilobed cyst in a pregnant woman twenty-four years old.

The cyst-wall varies in thickness from one millimetre to one centimetre; it is usually formed of connective tissue, but if it is thick, smooth muscular fibres also enter into its structure; in most cases it has an epithelial lining, usually of cylindrical, but sometimes of pavement epithelium. Graefe considers the origin of vaginal cysts under four heads: 1, these cysts may come from dilatations of lymph-vessels; this form is rare; 2, they may follow œdemas, contusions, or effusions of blood in the connective tissue; such cysts are not of frequent occurrence, and they have no epithelial lining; 3, they may be retention-cysts; the presence of glands in the vagina, denied by most anatomists, seems to have been established by Von Preuschen and C. Ruge; the cysts thus formed are superficial, and have thin walls; 4, cysts may be formed from a part of Müller's duct, or from Gaertner's canal, which is the excretory duct of the Wolffian body, and which remains in some of the inferior animals, but ordinarily atrophies in the human female; this hypothesis applies especially to large, thick-walled cysts.[1]

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[1] Zeitschrift für Geburtshülfe und Gynäkologie, 1882.

[2] Von Preuschen, Real-Encyklopädie der gesammten Heilkunde.

[3] Zeitschrift für Geburtshülfe und Gynäkologie. Band vii. Heft 2.

[4] Billroth's Handbuch der Frauenkrankheiten.

[5] Graefe, loc. cit.

[6] Boston Medical and Surgical Journal, 1861.

[7] Zeitschr. f. Geburtshülfe u. s. w.

[8] Archiv f. Gynäkologie, 1873.

The contents of cysts vary; in some cases the cyst contains a thin, light-yellow fluid, like that of a hydrocele, while in others it is as thick as starch or syrup, opaque, and dark-brown or chocolate-colored.

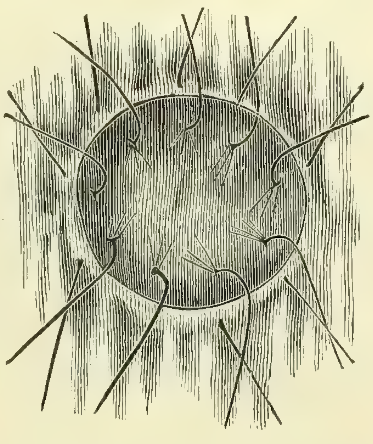
Colpohyperplasia cystica, also called *vaginitis vesiculosa*, or *vaginitis emphysematosa*, was first described by Winckel from his observing the disease in three pregnant women. The disease is characterized by the occurrence of semi-spherical bodies, from the size of a millet-seed to that of a pea, situated in the vaginal mucous membrane; they have a grayish color, are placed upon a swelled, light-red base, and are irregularly grouped. Puncture causes the escape of gas, sometimes quite audible, and the collapse of the cyst; the escape of gas may be followed by that of a few drops of serous fluid.

This disease has also been found in the non-pregnant. The origin of the cysts has not been satisfactorily explained, nor has the source of the gas in them. It has been suggested that the latter arises from the decomposition of trimethylamin in the secretion of glands whose efferent ducts have become obstructed. By some the presence of trimethylamin in the vaginal secretion has been denied, but this denial is an error, as the experiments of Zweifel[2] conclusively show.

The cysts found in colpohyperplasia cystica need no special treatment, for they disappear with the vaginitis with which they are associated; for this, antiseptic injections have been recommended, and carbolized water, or a solution of corrosive sublimate or of sulphate of copper, may be used.

Pedunculated cysts may be removed by excision with the galvano-cautery wire, or with the ligature and scissors. The treatment of other cysts has usually been by puncture, but this, even when followed by injection of a solution of iodine, does not cure, the cysts refilling; incision and cauterization of the cyst-wall with nitrate of silver offers more hope of cure, but still is not in all cases successful; the same may be said as to the treatment by seton or by drainage, and, even if a cure follows, it is protracted. Extirpation of the cyst is the most reliable means of treatment. But if the cyst-wall be thin, or if the cyst be very high, Hegar and Kaltenbach recommend Schroeder's method; this

Fig. 1402.



Removal of vaginal cyst by Schroeder's method.

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[1] Dr. Robert Watts (American Journal of Obstetrics, vol. xiv.) has reported a case of vaginal cyst developed from Gaertner's canal.

[2] Archiv f. Gynäkologie, Band xviii. Heft 3.

consists in removing that part of the cyst which projects above the vaginal surface, with the vaginal mucous membrane, and then stitching together the margins of the cyst and vagina, as shown in Fig. 1402; the exposed part of the cyst-wall which is left, covered with cylindrical epithelium, very soon assumes the characters of the vaginal mucous membrane, and cannot be distinguished from it. Extirpation of a portion of the cyst followed by tamponing the cavity may succeed. If hemorrhage after extirpation of a cyst be troublesome, it can be arrested by deep sutures; these also secure earlier healing.

FIBROIDS.—(*Myomata, Fibromyomata, Fibroid Tumors.*)—The vagina in comparison with the uterus is very rarely the seat of these tumors; Kleinwächter[1] has collected fifty cases. Myomata are the least, fibroid tumors the most frequent. The subjects are generally adults, though these growths have been found in children. They are somewhat more frequent upon the anterior than upon the posterior wall of the vagina. They may be sessile, or pedunculated, and in the latter case they are usually known as fibrous polypi. Their size varies from that of a pea to that of a child's head; in a case reported by Gremler,[2] the tumor weighed ten pounds and one ounce; they grow slowly, and rapidity of growth would indicate a sarcoma rather than a fibroma. They may originate in the submucous, in the muscular, or in the connective tissue surrounding the vagina. Macan[3] has reported a case in which the tumor was attached to the anterior and also to the posterior wall of the vagina, the secondary attachment being of course a consequence of ulceration. A small tumor may not cause any inconvenience or disorder, but a large one interferes with the functions of neighboring organs as well as with that of the vagina, and is not unusually a source of vaginal hemorrhage, or other discharge.

The only treatment of course is extirpation, and the method, when the tumor is pedunculated, is the same as in the case of pedunculated cysts. If the growth be sessile, enucleation is required, and in this operation, enough of the vaginal tissue over the tumor must be removed to prevent the formation of a pocket; the use of the fingers and handle of the scalpel in detaching the growth guards against hemorrhage during the operation, while deep sutures furnish the best security against this accident afterwards.

CANCER OF THE VAGINA.—Primary cancer of the vagina is exceedingly rare, as may be inferred from the statement recently made by Grammatikati,[4] that only thirty-eight cases of the affection have been published. In twenty-two cases analyzed by Küstner, two of the subjects were between fifteen and twenty, while nine were between thirty-one and forty years of age. The disease usually occurs upon the posterior wall of the vagina, while in those cases in which cancer extends to the vagina from the neck of the womb, the anterior wall is more frequently affected. The disease may be of either the epithelial or the scirrhous variety.

The *symptoms* are chiefly pain, offensive discharge, and hemorrhage; the pain is very slight in the early stages of the disease. Cancer of the vagina may present itself in the form of a broad-based papillomatous tumor, or of diffuse infiltration.

SARCOMA.—This disease is still less frequent than cancer of the vagina, Sänger,[5] in 1880, having been able to find only seven cases; since then a few

[1] Zeitschrift f. Heilkunde, 1882.

[2] Med. Zeitung, 1843.

[3] Dublin Journal of Medical Sciences, 1881.

[4] Centralblatt für Gynäkologie, 1885.

[5] Wiener med. Wochenschrift, 1880.

others have been reported. The seven referred to were two of Kaschewarowa, two of Spiegelberg, and one each of Fraenkel, Meadows,[1] and Mann.[2] To these, five have been added, by Sänger, Ahlfeld, Baiardi, Alexander R. Simpson,[3] and Soltmann.[4] Three of the cases have occurred in children, the oldest of them aged three years and a quarter; it is believed that in these the disease began in fœtal life. Sarcoma is liable to be confounded with cancer or fibroid, and a certain diagnosis can only be made by the microscope.

In cancer and sarcoma of the vagina, extirpation of the diseased structure gives the only hope. The operation has been done with the galvano-cautery, with the scalpel, and with scissors; Grammatikati used in his case Volkmann's sharp spoon. If possible, the scalpel or scissors should be employed, bleeding vessels being ligated if necessary, and sutures being used to unite the healthy tissue over the part from which the growth has been removed. In the great majority of cases the disease returns, but in a very few instances the cure seems to have been permanent.

Mucous Polypi of the Vagina.—These are analogous to mucous polypi of the uterus; they occur rarely, indeed their existence is doubted by some writers, while Scanzoni believes them to be more frequent than fibrous polypi. They may cause leucorrhœa and hemorrhage. Their removal is easily effected by torsion, by the écraseur, or by ligature and scissors; Eustache recommends the elastic ligature.

Hæmatoma.—Vaginal hæmatoma is frequently associated with hæmatoma of the vulva; they have the same causes, and require the same treatment. Murray[5] has given an interesting case of hæmatoma occurring in a girl seventeen years of age, caused by falling from a trapeze. The tumor, examined a month after the accident, was in the anterior wall of the vagina, was pear-shaped, and pushed the neck of the womb upward; eight ounces of dark, unclotted blood were removed with an aspirator, and recovery followed.

Uro-Genital Fistulæ.

Uro-genital fistulæ are abnormal communications between the urinary and the genital organs. From the fact that such communications in the great majority of cases involve the vesico-vaginal wall, all have been sometimes included under the name of *vesico-vaginal fistulæ*, but these constitute only one form of the lesion. The abnormal opening may be in the urethro-vaginal wall, and then the fistula is called *urethro-vaginal;* if one of the ureters communicates with the vagina, the fistula is *uretero-vaginal*, and if with the uterus, it is *uretero-uterine;* if there be an opening from the bladder into the uterus, the fistula is *vesico-uterine.* It may happen that two

Fig. 1403.

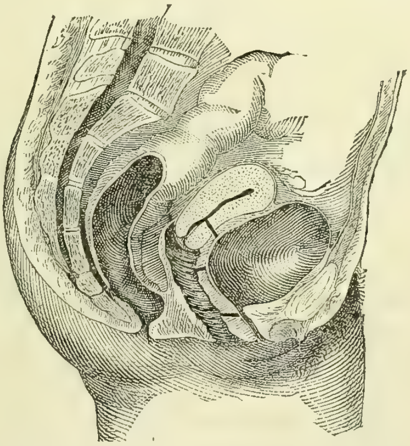

Diagram showing various forms of uro-genital fistula.

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[1] London Obstetrical Society's Transactions, vol. x.

[2] American Journal of Obstetrics, vol. viii.

[3] Transactions of Edinburgh Obstetrical Society, vol. v.

[4] Schmidt's Jahrbucher, 1882.

[5] Philadelphia Medical Times, 1877.

or more of these fistulæ are united; thus the lesion may occupy the urethral and the vesical wall, and then the fistula receives the name of *urethro-vesico-vaginal.* Fig. 1403 represents diagrammatically three fistulous openings from the urinary into the genital organs, viz., urethro-vaginal, vesico-vaginal, and vesico-uterine. Congenital fistulæ, designated as *cloacal uro-genital fistulæ*, are omitted from this classification.

ETIOLOGY OF URO-GENITAL FISTULÆ.—Winckel,[1] and recently Levrat[2] has followed his example, divides uro-genital fistulæ, in regard to their causes, into puerperal and non-puerperal; he includes among the former not only all those which occur in labor and in the lying-in state, but also those which may occur in pregnancy. This etiological classification seems arbitrary and of doubtful value, and it would be better to exclude from the class of puerperal fistulæ those which occur before confinement. Probably eighty per cent. of all these lesions, requiring professional treatment, are produced in labor, although not becoming manifest in many cases until a few days afterwards. They usually result from the violent and continued compression of the tissues concerned between the child's head and the mother's pelvis; this compression may be brief or protracted—in the majority of cases it is the latter—but even if it lasts only twenty or thirty minutes, the death of tissue may be as certain as if it had continued for hours. The obstetric forceps has sometimes been unjustly reproached as the cause of the injury; but when we remember that the blades of this instrument are most frequently applied with reference to the sides of the mother's pelvis, the improbability of their causing this lesion is obvious. Moreover, the statistics of Emmet, including 202 cases, show that in less than fifty per cent. of cases of puerperal fistulæ has the forceps been used, delivery in the majority having occurred without instrumental aid. Emmet furthermore positively asserts that he has "never met with a case of vesico-vaginal fistula which, without doubt, could be shown to have resulted from instrumental delivery." The accident is not limited to cases of cranial presentation, but has occurred in labors where the shoulder or the pelvis has presented.

Bandl[3] states that the long duration of labor in a narrow pelvis, or the unyielding condition of the soft parts, is by far the most frequent cause of these fistulæ. All authorities agree that accumulation of urine in the bladder is an important factor in causing the injury; and Emmet urges that, before instrumental delivery, the bladder should be emptied by aspiration, if the introduction of the catheter is impossible, in case there is impaction of the presenting part. In a very large proportion of cases the urine has not escaped from the fistulous opening until some days after delivery, but in some the escape has been observed immediately after.

Beside impaction of the head, or other presenting part, in labor, leading to necrosis of the tissues, other causes of this accident have been wounds of the vesico-vaginal wall by fragments of the fœtal skull, in craniotomy, and the accidental opening of a cystocele which had been mistaken for the bag of waters. Deroubaix[4] refers to ulcerations occurring in the puerperal state as causes of these lesions; he says that while such ulcerations may be observed in an otherwise normal condition of the subject, and generally have their origin in some wound made in delivery, yet that the danger of loss of substance is much greater in epidemic puerperal fever.

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[1] Die Krankheiten der weiblichen Harnröhre und Blase. (Billroth's Handbuch.)

[2] Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques, tome xxxviii.

[3] Real-Encyklopädie der gesammten Heilkunde.

[4] Traité des Fistules Uro-Génitales de la Femme.

Non-puerperal fistulæ result from vaginal lithotomy; from cystotomy done for the cure of cystitis; from accidental traumatisms, such as gunshot wounds, or those caused by falling or sitting upon pointed bodies which, entering the vagina, penetrate the vesico-vaginal wall; from the pressure of pessaries, too long worn, of too great size, or of unsuitable form, wearing away the part of the anterior vaginal wall with which they are in contact, or from that of vesical calculi, or of foreign bodies, as for example a needle case, introduced into the bladder, and similarly producing perforation of the wall, but from its vesical side; from ulcerations, cancerous, tuberculous, or syphilitic; from abscesses in the vesico-vaginal wall; and from tumors. Deroubaix mentions a case in which a fistula was caused by the violent introduction of the finger into the vagina of a woman while she was urinating. In some instances a vesico-vaginal fistula has been produced by accidentally tearing or cutting into the bladder in an attempt to form a vagina where this passage has been congenitally absent.

SYMPTOMS AND DIAGNOSIS.—The dominant fact is the escape of urine by the vagina. This escape may be constant or intermittent; it may vary with the position of the patient; all or only a part of the urine may thus pass involuntarily. In spite of careful cleanliness, the sufferer diffuses around her an ammoniacal odor, the external organs of generation and the adjacent parts of the thighs are inflamed, swelled, and excoriated; and the external surface of the buttocks is also inflamed. Calculous deposits may occur in the vagina, about the borders of the fistula, and in the bladder. Menstruation is in many cases suppressed, in others normal, and in still others irregular; there is relative sterility, which has been attributed to the poisonous influence of the urine upon the spermatozoids; according to Simon's observations, should impregnation occur, abortion or premature labor follows.

A digital examination is sufficient in some cases to detect the fistula, if it be urethro-vaginal or vesico-vaginal, and of notable size. In all cases a visual examination should also be made, and this is best done by having the patient lie upon her side, while the anterior vaginal wall is exposed with a Sims's speculum. If the destruction of the vesico-vaginal wall has been extensive, more or less of the anterior vesical wall may be seen protruding into the vagina in the form of a soft tumor of a vivid red color. The uterine sound or probe may be used if the fistulous opening be small; the instrument may be introduced through either the vagina or the urethra. Still failing to recognize the opening in the vesico-vaginal wall, a colored fluid—warm milk is very good for the purpose—may be injected into the bladder, when the observer watches its escape, either by drops or in a stream, into the vagina, and is thus guided to the discovery of the opening. Should, on the other hand, the fluid not escape through any part of the urethro-vesico-vaginal wall, but be found entering the vagina from the os uteri, it would show that the opening was between the bladder and the uterus.

But if one of the ureters empties into the vagina, or into the uterus, the diagnosis is more difficult. In case of either of these lesions, one-half of the urine is passed through the urethra, and the other half escapes involuntarily; now, if having this obvious truth in mind, the surgeon make the patient, immediately after emptying her bladder, sit for two hours or more on a suitable vessel, this will contain at the end of that time the urine which has escaped involuntarily; then by catheterization or by voluntary action the bladder may emptied into another vessel, and the amounts compared; if about the same, the proof is conclusive, after excluding any error by the previous examination, that the quantities discharged have been from the two ureters. Again, if there be a uretero-vaginal fistula, by careful exposure of the anterior vaginal wall and watching it for a few minutes, the observer will see the urine escaping, usually not far from the cervix—below it and a little to one or the other side—in small, intermittent jets; and a fine probe may be introduced through this opening into the ureter. If there be an escape of urine from the os uteri, and on the other hand no similar escape of fluid injected into the bladder, the conclusion is that the fistula is uretero-uterine.

Complications.—There may be cicatrices in the vagina, narrowing the canal so that even complete exposure of the fistula is impossible; the uterus may be displaced; the vaginal portion of the cervix may be more or less completely destroyed; peri-metritis or para-metritis may have followed the original injury, resulting in "thickening and nodosities in the ligaments, and adhesions between the different pelvic organs."[1] The urethra may be contracted or closed.

Treatment.—In a few instances, spontaneous cure of a uro-genital fistula has occurred; Emmet mentions two such cases, in which the patients entered the hospital immediately after delivery, the fistula being large enough to permit the introduction of the finger; in each case the opening closed within a month, no treatment but the use of warm water injections having been employed. Emmet believes that such injections, properly applied, would cause the closure of many of these openings, and that in every instance the sloughing process would be arrested.

The *curative treatment*, which most uro-genital fistulæ require when they come under the care of the surgeon, consists in denudation of the borders of the fistula, and their union by sutures. Of course, all complications which would interfere with the performance or the success of the operation, as well as local inflammation, must be first removed. The closed urethra, for example, must be reopened; calcareous deposits, whether intra-vesical or intra-vaginal, must be taken away; the borders of the fistula must be brought into a healthy condition by frequent warm-water injections, and by occasional applications of a solution of nitrate of silver.

Where the vagina is narrowed by cicatrices, these should be divided with scissors, and subsequent contraction should be prevented, as well as absorption of cicatricial tissue promoted, by means of suitable vaginal dilators; Bozeman has especially made known the importance of this part of the preparatory treatment, and has instituted a method which has greatly contributed to the success of his operations. Attention must also be given to the patient's general health.

Position of Patients; Instruments; Sutures, and Methods of Fastening them.—Those who follow the method of the late Dr. J. Marion Sims cause the patient to lie upon her side. Simon directed that she should lie upon her back, while Bozeman has an apparatus to which she is fastened in the genu-pectoral position. In the first position Sims's speculum is used, in the second Simon's, and in the third Bozeman's. Tenacula, or tenaculum-forceps, scissors or knives for freshening the fistulous margins, sponge-holders and sponges, needles and needle-holders, and material for sutures, are to be at hand. Scissors are generally preferred to knives for paring the fistulous edges, and silver wire for the sutures, though Simon, whose success was remarkable, used Chinese silk for this purpose. Silk sutures of course are tied. Most operators who use wire, secure the sutures by twisting, but Bozeman uses a perforated disk of metal, through which the ends of the sutures are passed, a perforated shot being then placed over the two ends of each suture, and firmly compressed; this is known as Bozeman's button-suture. In order to facilitate the operation Simon passed two threads through the cervix, and by these drew the uterus, and with it the fistula, downwards, thus rendering the latter more accessible. Simon's method is illustrated in Fig. 1404. The patient is supposed to be lying upon her back; the fistulous margin has been denuded, but the sutures are not yet introduced.

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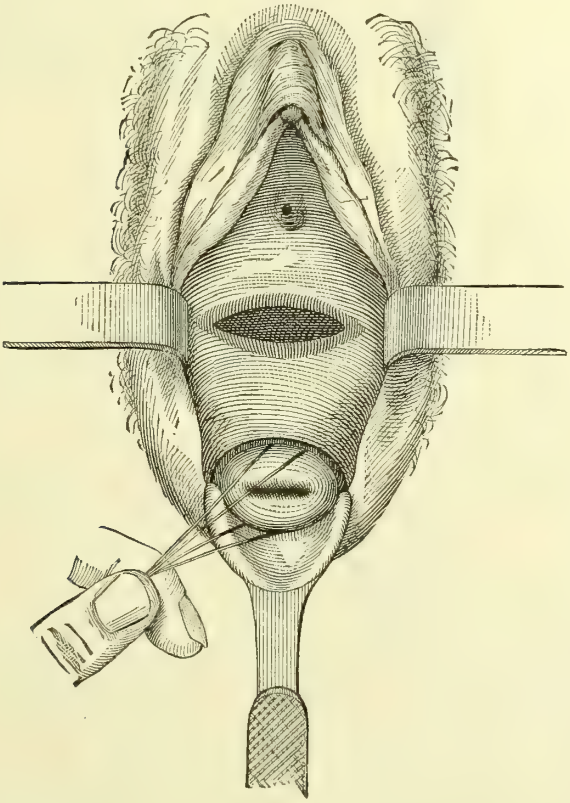
[1] Hegar und Kaltenbach, op. cit.

Fig. 1404.

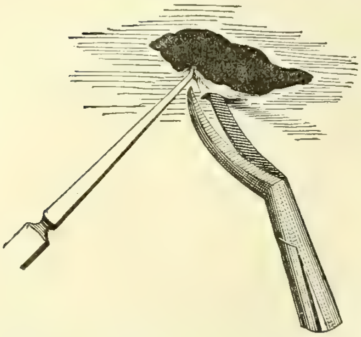


Simon's operation for vesico-vaginal fistula.

Having referred to some of the peculiar methods of different operators, I shall in the following description speak chiefly of that used by Sims and Emmet, and by those who adopt their method, which is especially known as the "American method." The patient is etherized, and lies upon her left side, the perineum being retracted with a Sims's speculum; if the form and position of the fistula will permit, the edges should be united by stitches passing from below upwards, rather than from side to side; in other words, a transverse fistula, such as is represented in Fig. 1404, can be closed more readily, and with greater probability of success, than if the fistula is longitudinal.

If the fistula be large and if the vesical wall protrude into the vagina, a sponge may be used to push it back and keep it from again protruding;

Fig. 1405.



Vesico-vaginal fistula ; freshening the edges.

Verneuil recommends for this purpose a thin rubber bag with tube and stopcock, which can be introduced empty and can be subsequently distended with air, being allowed to collapse again before removal. It is better to begin the denudation at the most dependent part of the fistula, and to ascend from it, so that the flow of blood may not conceal the tissues to be cut. A tenaculum is used to catch the vaginal wall at the point of beginning, and the operator holds this with his left hand so as to make the part slightly tense, and thus facilitate the use of the scissors. At least

Fig. 1406.

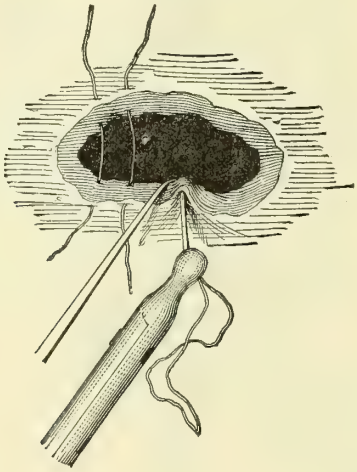


Fig. 1407.

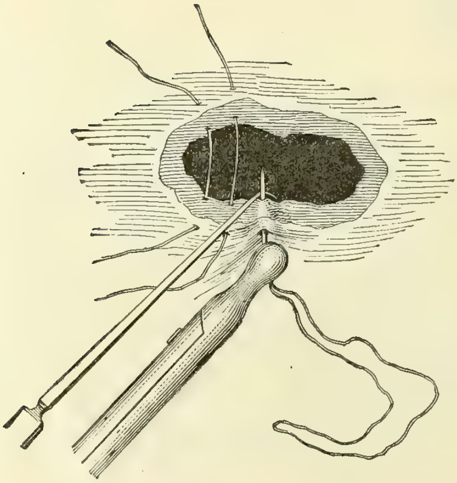
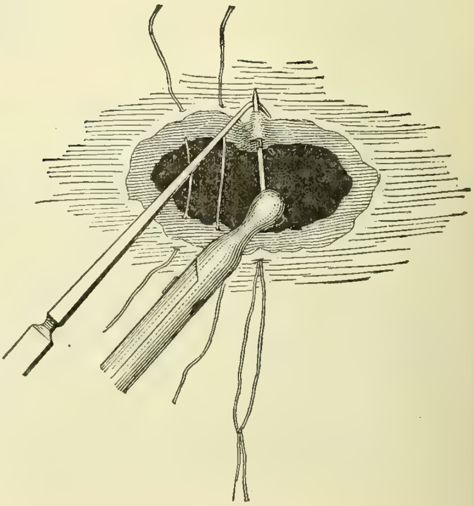


Fig. 1408.



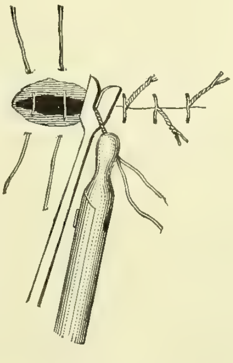
Vesico-vaginal fistula; introduction of the sutures.

two pairs of scissors, with different curves, are required. The annexed illustration (Fig. 1405) shows the tenaculum introduced, and the freshening of the fistulous margin begun.

The part excised should not include the vesical mucous membrane, but the raw surface left by the denudation should be somewhat bevelled, broader at the vaginal surface, and thence sloping to the inner wall of the bladder. If possible, the tissue cut away should be in a single piece, for then the operator is sure that the denudation is complete, and that no little islands of vaginal mucous membrane are left to prevent union. After a symmetrical and sufficient denudation, the next step is the introduction of silver-wire sutures. (Of course, if a sponge has been introduced, this must be first removed.) One of Emmet's needles, round, tapering somewhat toward the point and there slightly curved, and about half an inch in length, is threaded with silk so that a loop is formed, the two ends entering the needle's eye from opposite sides, and one being tied with a half knot round the silk close to the eye; the loop should be about six inches long. The tenaculum is used to catch up the part and hold it for the entrance of the needle, and, after the point of the needle has penetrated the tissues, is so placed as to exercise counter-pressure around it, and thus facilitate its complete passage; the needle is passed to, not through, the vesical mucous membrane. After bringing the needle and silk through both sides of the fistulous orifice, a piece of silver wire, sharply bent at one end, is hooked in the loop, and is then readily pulled through by the same. The accompanying illustrations (Figs. 1406, 1407, 1408) show the different steps which have been thus briefly described.

The needle is entered about half an inch, or somewhat less, from the border of the denuded tissue; the sutures are about one-sixth of an inch apart. The operator, in fastening the sutures, first draws the two ends of the suture somewhat tense, so that there may be no loop or twist of either, and then "shoulders" each, that is, bends it at a right angle to the tissue at the point of its emergence; next the two ends are twisted together until they hold the opposite parts in exact apposition, and no more, for if the twisting be carried farther, there is danger that the suture will cut out; after the twisting, the wire is bent so as to lie flat against the vaginal wall, and is cut off so that only half an inch is left exposed; Emmet directs that the sutures shall be laid upon the vaginal wall pointing alternately in opposite directions. The subjoined diagram (Fig. 1409) illustrates the appearance of the wires after "shouldering" and twisting, and after the twisted wires have been pressed down upon the vaginal wall and cut off; it also shows one suture being twisted, and two yet remaining to be secured. The number of sutures introduced should be carefully counted, so that when the time for removal comes, none may be left behind.

Fig. 1409.



Vesico-vaginal fistula; twisting the sutures.

After the sutures have been fastened, it is well to wash out the bladder with warm water, thus freeing it from any blood that may have collected during the operation: if any of the water should escape from any part of the line of closed fistula, it would indicate that the closure was insufficient, and that one or more additional sutures were required. After this the patient is placed upon her back in bed, and Sims's sigmoid catheter is introduced.

This "should[1] be made of block-tin, so that the curve may be altered to

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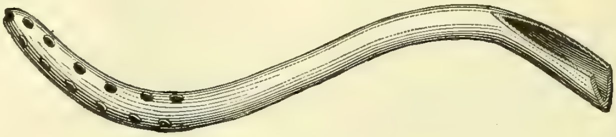
[1] Emmet.

suit each individual case. It should not touch the fundus of the bladder, yet it ought to be of sufficient length to be properly balanced in the urethra, and to lie close up behind the pubis. If the fundus of the bladder rests on the point of the catheter, as it often does when the instrument is not properly curved, it will have a tendency to turn to one side." . . . "It must be withdrawn, and the necessary change made in its shape until the proper curve has been gained. A want of attention to this point will lead to much irritation of the bladder, and will cause a failure of the operation. Perforation of the bladder, and even death, may result from neglect of this, as I have known to happen in one instance." "The catheter is generally made five inches long before being bent to the proper curve; a greater length, however, is necessary if the patient is unusually fat. As a receptacle for the urine, a large-sized oval cup, such as is found in bird cages, may be used, or one of any other convenient shape, with a bottom too broad to turn over." Or instead of the receptacle for urine being in the bed, a piece of flexible rubber-tubing may be attached to the external end of the catheter, and thus the urine may be conveyed into a vessel by the side of the bed. The patient should be carefully watched, since any cessation of the urinary discharge requires the immediate withdrawal of the catheter, and its thorough cleansing from all obstruction; meantime another catheter takes its place. The catheter in all cases requires frequent cleansing during each twenty-four hours. The patient should lie upon her back most of the time; the bowels are to be kept confined by the daily use of opium; liberal diet is to be directed. The sutures may be removed in from eight to ten days, and then the bowels are moved. "The catheter[1] may be continued in use for a few days longer, according to circumstances, and after from the fourteenth to the twentieth day the patient may sit up."

Fig. 1410.



Sigmoid catheter.

In rare instances the bladder is intolerant of the permanent catheter; in these, therefore, the urine should be drawn off at regular intervals, usually once in three or four hours. Some operators have dispensed with the catheter altogether, allowing the patients to spontaneously empty the bladder (Simon and Meadows); but the practice would probably succeed only in cases where the fistula was small, and it has rarely been followed.

Cystitis may occur within a few days after the operation. The ropy discharge then often clogs the catheter, and the patient suffers from more or less vesical tenesmus; if this be great, the probability is that a part at least of the newly united surfaces will give way. The use of opiates and diluent drinks, washing out the bladder with warm water containing a little salt or potassic chlorate, and scrupulous care that the catheter shall be kept entirely pervious, chiefly constitute the treatment of this condition.

Hemorrhage during the operation can generally be controlled by hot-water vaginal injections, or by the use of ice. Secondary hemorrhage is occasionally met with, and may be fatal, or, when this rare result does not occur, will probably prevent the success of the operation. If the bleeding can be arrested by the introduction of one or more sutures, this method should be employed. But it may occur at night, and the use of sutures may be impossible, when dependence must be placed upon thorough vaginal tamponing, with the use of an abdominal bandage and a large compress firmly applied over the bladder.

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[1] Emmet.

Special Methods Necessary in Different Varieties of Fistula.—If two vesico-vaginal fistulæ are situated near to each other, it is better to divide the bridge of tissue intervening between them, making a single fistula to be denuded and united, than to operate upon each separately. If a vesico-vaginal fistula be very large, it may be necessary to unite the margins in different lines, as, for example, one longitudinal, and two oblique and diverging from it, presenting an appearance somewhat like that of the sagittal and lambdoidal sutures of the fœtal head.

Vesico-uterine fistulæ, which, according to Emmet, result from anterior lacerations of the cervix which have healed over, leaving sinuses between the uterine canal and the bladder, are treated by laying the track of the sinus open, denuding the tissues with scissors or a small scalpel, and approximating them with sutures introduced with a long straight needle. This is the method of Emmet. Kaltenbach operates by splitting the cervix up to the vaginal junction, then drawing the uterus down to the inferior third of the vagina; denudation and the introduction of sutures follow. *Hysterocleisis*, or uniting the lips of the womb together, is an operation which was employed by Jobert, while *episiostenosis*, or closure of the vulva after making a recto-vaginal fistula so that the urine might be passed through the rectum, was practised by Rose in a case of genito-urinary fistula believed to be otherwise incurable. *Colpocleisis*, or obliteration of the vagina, is also another method of treating such fistulæ, but it is only indicated, according to Hegar and Kaltenbach, when in "addition to the impermeability of the canal certain complications are present, such as absolute inextensibility of the lips of the fistula, their invasion by cicatricial tissue complicating a fistula situated very high, the adherence of the fistula to the pelvic bones, or the danger, in operating, of wounding important organs."

Uretero-uterine fistula has been treated by Hahne and by Simon by making a vesico-vaginal fistula, and then closing the vagina below this point; by Zweifel and by Credé, by extirpation of the corresponding kidney.

In 1867[1] I operated successfully upon a *uretero-vaginal fistula* of fourteen years' duration, by making first a vesico-vaginal fistula—cutting from the ureter into the vagina—then after a few days denuding a comparatively large surface of the latter, and finally inverting that surface so as to throw the ureteral orifice into the bladder. At that time I had never seen any report of a similar lesion, and the diagnosis was not readily made; the treatment was still more difficult, and it was not until after more than one failure that I finally succeeded.

Even now the literature of the subject is scanty, and I cannot find any method of treating this lesion more promising, though others may be more ingenious, and are more complicated, than that which I have described.

RECTO-VAGINAL FISTULÆ.

Recto-vaginal fistulæ are openings between the rectum and the vagina. They are much rarer than uro-genital fistulæ, and probably a smaller proportion have their origin in childbirth. Those that thus originate may be caused by continuous pressure of the presenting part of the child, resulting in subsequent sloughing, and must necessarily affect only the lower portion of the rectum. More frequently, however, they follow a complete rupture of the perineum which has only partially healed; or, though the perineum may be completely restored, there may remain an ununited wound above, in the recto-vaginal wall. Schroeder says that he has seen a double perforation into the rectum occur in childbed, from deep-seated diphtheritis of the posterior vaginal wall. Non-puerperal fistulæ may result from cancerous or from syphilitic ulceration, or from an abscess in the recto-vaginal wall which opens into each canal; an example of the last, occurring a few days after normal labor, is given by Velpeau. They may also be caused by the penetration of a foreign body through the rectum and vagina, as by impalement. Amussat treated a girl of eighteen for a fistula as large as a goose-quill, which had resulted from an injury received when she was six years old; this injury had been caused by her falling upon the end of a broom-handle which had penetrated into the rectum and vagina, and had destroyed the recto-vaginal septum; recovery had been complete, except that this fistula remained. A foreign body in the rectum may cause perforation from this canal into the vagina; but more frequently the accident has happened from a badly fitting pessary perforating from the vagina into the rectum.

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[1] Western Journal of Medicine, October, 1867.

Recto-vaginal fistulæ vary in size, some being so small that only a fine probe can enter, while others are so large that almost the entire recto-vaginal wall is destroyed; only rarely, however, do they measure more than a centimetre and a half, or two centimetres, in their longest diameter.[1]

The passage of fecal gas, or of feces, or of both, through the vagina, is the characteristic indication of the lesion. If the fistula be large enough, it can be detected both by vaginal and by rectal touch. A visual examination is made with the patient lying in the dorso-sacral position, and a univalve speculum is used to lift up the anterior vaginal wall. If the fistula be so small that it eludes detection by this means alone, a colored fluid should be injected into the rectum, and then the place of its escape into the vagina will be seen.

Spontaneous cure of puerperal recto-vaginal fistulæ seldom occurs. If the lesion be from cancer, no attempt at cure should be made, and if it be syphilitic—which, according to Emmet, is most probable if there is a stricture just within the anus—any such attempt must be postponed until after suitable constitutional treatment has been employed; moreover, in this case, cure of the stricture must precede an operation upon the fistula.

Cauterization with nitrate of silver, or with a point of hot iron, may be employed, according to Hegar and Kaltenbach, with a probability of success if the fistulous opening be no larger than a pea; but if no notable diminution in the size result, the cauterization should not be repeated. In many cases denudation of the borders of the fistula, or of the sides of the fistulous track, and the application of sutures, will be required. One of three methods, which are distinguished as vaginal, rectal, and perineal, may be employed, the selection being made according to the peculiarities of the case. As a preliminary to any method of operating, the patient's bowels are thoroughly evacuated.

In the *vaginal operation*, the patient is in the dorso-sacral position; the anterior vaginal wall may be lifted up by a univalve speculum, lateral dilators may be used, and a tenaculum hooked into the fistulous margin; it is sometimes advised to insert a finger into the rectum, in order to more completely expose the fistula; another method of exposing it and of rendering its margins somewhat tense, is to introduce into the rectum a large-sized Hegar's dilator, No. 24, for example. The freshening of the fistulous borders is done as in the operation for vesico-vaginal fistula, and so too is the application of sutures; these are preferably introduced from below upwards, rather than from side to side; in other words, a transverse fistula is more readily cured than a longitudinal one, the tissues yielding more readily from above downwards than laterally.

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[1] Hegar und Kaltenbach, op. cit.

In the *rectal method* the patient lies either upon her back or upon her side. This method, according to Emmet, should be limited to fistulæ of moderate size, and to those in which the sides of the opening cannot be readily brought together from the vagina; denudation causes more hemorrhage, and the stitches are more liable to cut out, than in the vaginal operation. A univalve speculum is used to draw back the posterior rectal wall, and a retractor is employed for each side of the anus, while a finger in the vagina assists in exposing the fistula. The further details of the operation have been sufficiently indicated in speaking of the vaginal method. Levrat has suggested combining these operations. He proposes separating, all around the circumference of the fistula, both the rectal and the vaginal mucous membrane, and then introducing two sets of sutures, one on either side. In any case, if rectal sutures are to be used, it is probable that those of catgut will be the most convenient and satisfactory. In a case in which there had been great destruction of the recto-vaginal wall, and in which the retroflexed uterus had descended quite low, Simon united the anterior lip of the womb to the inferior border of the fistula, when of course all uterine discharge passed into the rectum.

The *perineal method* is employed when the fistula is otherwise inaccessible, or, according to Emmet, when it is situated "directly against the sphincter," whence a difficulty of obtaining good union because of the contractions of the muscle. Emmet advises dividing the perineum and sphincter directly to the fistula by scissors, freshening the sides of the fistula, and uniting the tissues as in perineal laceration. Hegar and Kaltenbach employ for the preliminary section a probe-pointed bistoury, or a scalpel and director.

After an operation for recto-vaginal fistula, the treatment, especially as regards the management of the bowels, will be the same as that advised after perineorrhaphy and perineoplasty.[1]

DISEASES OF THE CERVIX UTERI.

Ulceration of the Cervix.—If there be procidentia of the womb, one usually sees in the vicinity of the external os one or more depressed cavities, with somewhat irregular borders, and here we have true ulceration, an actual destruction of tissue. But excepting the ulcers thus presented, and those which occur in syphilitic or in malignant disease, true ulceration of the cervix is rarely found. It has been customary to divide benign ulcers of this part into simple, granular, vegetating, and varicose. In all these varieties, however, no loss of tissue is found, the supposed ulcer, so far from being depressed, usually presenting a surface elevated above the surrounding tissues. As West[2] said more than thirty years ago, "the ulcerations of the os uteri seldom or never present an excavated appearance with raised borders, as ulcers of other parts often do; but either their surface is smooth, or it projects a little beyond the level of the adjacent tissue." But what is the significance of these conditions which practitioners have for a generation been describing and treating as ulcerations of the cervix? In the simplest form of these disorders, *erosion*, a condition observed possibly upon both lips of the womb just external to the os uteri—if restricted to one, it is almost invariably the posterior which is affected—there is a bright-red, slightly roughened surface which is in marked contrast with the smooth, lighter-colored, normal mucous membrane of the cervix. This condition should be no longer regarded as a simple epiphenomenon of parenchymatous metritis, but as the result of the injurious action of a discharge from the cervical canal, causing desquamation of superficial epithelium; hence the posterior lip is more frequently than the anterior the seat of this supposed ulceration, or, if both are affected, the manifestation is more decided upon the former. This condition has been aptly compared to the red, inflamed state of a part of the upper lip of a child, suffering with coryza, the discharge from the nose in that case producing the irritation. In the second form of ulceration, there is apparently *papillary hypertrophy* which reaches its highest development in the third. The presence of *varicose veins* is an accidental complication, which gives its name to the fourth variety of cervical ulceration.

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[1] See page 688, *supra.*

[2] Croonian Lectures, 1854.

But this is not all. There will be observed in many cases of ulceration of the cervix, glandular structures, the glands being so enlarged as to form notable tumors containing liquid contents, the so-called *ovula Nabothi*. As there are no glands in the external mucous membrane of the cervix, these manifestations can only come from eversion of the internal cervical membrane where glands are remarkably abundant. Such eversion may occur when the cervix has suffered from no traumatism—in the virgin, for example—but it is especially liable to follow an unhealed tear of the cervix caused by abortion or labor, and a consequent catarrhal inflammation of the cervical canal, or even of the uterus as well.

Taking this view of the pathology of ulcers of the cervix, the plan of treatment is comparatively simple, and quite obvious. Remove the inflammation, and thus the cause of the disease. In slighter cases of erosion, by applications of a weak solution of nitrate of silver, of tannin and glycerine, or of some other astringent, we can in many cases stop the oozing from the raw surface, cause it to heal over, and, for a time at least, make the patient very much better. But as long as the source of the mischief remains, recurrence is almost certain, and, therefore, the catarrh of the cervix and body of the uterus must be treated in order to insure the permanency of the cure. Uterine congestion must be lessened by hot-water injections, by the introduction into the vagina of tampons of cotton saturated with glycerine, and by putting the uterus, if displaced, in a normal position; constipation must be prevented, and the general course of life so controlled that suitable hygienic rules shall be observed, while tonics, vegetable or mineral, may be administered as the individual case may require; it is possible that ergot and nux vomica may contribute somewhat to lessening uterine hyperæmia; especially let care be given to securing normal menstruation. Some are content with this treatment, and reject all applications to the cavity of the neck or of the body of the womb. Probably this is too great a reaction from the excess and violence of the local treatment of the uterus which was in vogue a few years ago. Many cases will be benefited by dilatation of the cervical canal—this dilatation being effected, not by bladed instruments, but by bodies which will press uniformly upon hypertrophied tissue, and thus stimulate absorption—and after this by the occasional application of either Churchill's iodine or iodine in its nascent state.

When the discharge from the uterus persists, and especially when it is thin rather than thick and tenacious, similar applications to the endometrium will be beneficial. Carbolic acid, either in combination with iodine, or alone, dissolved in glycerine, is a favorite application with some practitioners.

In the graver forms of so-called ulceration a somewhat similar treatment may be pursued. Some resort to the actual cautery, but L. de Sinéty gives his preference to chromic acid dissolved in an equal quantity of water. The application is made by means of a cotton-wrapped probe, or applicator, dipped in the solution, the adjacent parts of the uterine neck and of the vagina being protected by a roll of cotton first placed in a solution of bicarbonate of sodium; the application is followed by an injection of warm water. If necessary, the chromic acid solution may be applied to the cavity of the cervix.

Thorough tamponing of the upper portion of the vagina by means of iodoform-cotton dipped in glycerine, at intervals of three or four days, is often beneficial. For this to be done, the patient should lie upon her side, and the cervix should be exposed by a Sims's speculum; any displacement of the uterus is if possible first corrected, and then small pieces of iodoform-cotton, the size of a hulled walnut or rather smaller, after being dipped in glycerine, are carefully applied around the cervix, and if there be laceration the everted lips are pressed together by means of these balls; the packing is continued until the upper third of the vagina is filled. The iodoform-cotton of the shops contains a much less quantity of the drug than cotton will take up; to prepare it properly, loose cotton should be dipped in a saturated ethereal solution of iodoform, a deodorizer, oil of bitter almonds for example, being added, and then slowly dried. As a substitute for iodoform-cotton, simple cotton dipped in glycerine, that part of it which is to be in contact with the cervix being thickly covered with iodoform-ointment, may be used. The ointment may be made by thoroughly incorporating from one to two drachms of iodoform with one ounce of vaseline: two or three drops of oil of bitter almonds should be added.

The preparatory treatment advised before operating for a lacerated cervix may also be adopted.

If amendment under this treatment be incomplete, or only temporary, the question of tracheloplasty, elsewhere considered, will arise if the disease have originated in a childbirth injury to the cervix.

HYPERTROPHY OF THE CERVIX.—It is usual to divide cervical hypertrophies into those of the vaginal portion, those of the middle portion, and those of the supra-vaginal portion.

(1) *Hypertrophy of the Vaginal Portion.*—In this variety of hypertrophy, which is usually congenital, the lower portion of the cervix may reach to the mouth of the vagina, or may even protrude from the vulva. The cervix is conical in form, and presents a uniform consistence. The vaginal vault is not depressed, but has its usual height, both anteriorly and posteriorly. If the woman be married she is sterile, and suffers more or less in sexual intercourse.

There is but one remedy for this condition, amputation of a portion of the cervix. The scissors is the best instrument for performing the operation, and the method of operating is that described as Simpson's.

(2) *Hypertrophy of the Intermediate Portion.*—In this variety the posterior vaginal vault is of the normal height, but the anterior has disappeared, the anterior wall of the vagina being prolapsed. Here again the surgical treatment most frequently resorted to is amputation, an incision being first made so as to divide the lips to the required height, and each lip being afterward cut off; sutures are then introduced.

(3) *Hypertrophy of the Supra-Vaginal Portion.*—Here the hypertrophy affects that portion of the uterus which is situated above the vaginal attach-

ment. The vagina is more or less prolapsed, so that both the anterior and the posterior vaginal vault have disappeared, and the condition simulates a simple prolapsus of the uterus. Upon bimanual examination, however, the fundus is found occupying its normal height, and a sound introduced into the os penetrates five or six inches or even more, instead of only two and a half or three inches; hence there is elongation, whether this be hypertrophic or caused by simple stretching of the tissues. It is not unusual to find, in these cases, a bilateral laceration of the cervix, and the lips present the form of a mitre.

Emmet's views differ from those generally accepted as to this condition. He holds that true elongation of the cervix does not exist, but that double laceration of the cervix is frequently mistaken for it; if the patient be placed on her knees and chest, with her clothing perfectly loosened about the waist, and if air be admitted into the vagina, the hypertrophy and elongation of the cervix disappear, and often the cervix seems to be smaller than natural. Again, according to Emmet, in some cases of sterile and unmarried women the uterine body becomes elongated when the subject stands, and while the fundus remains stationary the tissues below stretch out, as if formed of soft putty, becoming elongated by their own weight. "In this prolapse the uterine neck is pushed forward in the vagina, and frequently beyond the outlet, and the supra-vaginal portion of the uterus appears with a covering of the vagina, presenting the appearance of an enlongated cervix." These views are of such great practical importance that they are sure to attract general professional attention, and I believe that in the main they will ultimately meet with general professional acceptance.

Of course, if the condition be that which was originally fully described by Huguier, and for which the conoid amputation of the cervix was devised by him, that operation will be indicated; the method of performing it is given on page 737. According to Emmet, it is only after every reasonable procedure has been tried without benefit, that a portion of the cervix may be removed as a last resort and as an experiment; among the remedies to be tried he mentions glycerine-tampons, a blister applied to the cervix after each menstrual period, an intra-vaginal, and an intra-uterine stem pessary.

If laceration of the cervix be present, the two lips appear as triangular, pale projections; amputation of these will for the time at least be followed by as favorable results as tracheloplasty, and can be more rapidly done. Nevertheless, Emmet objects to the former operation, because after complete uterine involution, should a pessary be required to prevent posterior displacement of the womb, it will be difficult to keep the organ in place when so much of the vaginal cervix has been removed. It is, therefore, better, as a rule in these cases, to perform tracheloplasty. Further, in such cases there has usually been so much injury to the pelvic floor in labor, that the permanent cure of the prolapsus must finally be effected by Emmet's operation for this condition, described on page 744.

Fibroid Tumors of the Cervix.—The neck of the womb is very much less frequently the seat of fibroid tumors than the body, but when these occur in the supra-vaginal cervix, they present the same varieties as those found in the former situation, to wit, submucous, interstitial, and subperitoneal. Fibroids of the vaginal portion must obviously be either interstitial or submucous; they rarely attain great size. These tumors may cause sterility, by producing either hemorrhage or uterine catarrh. If pregnancy occur, they may present an insuperable obstacle to the passage of the fœtus, requiring an operation for their removal—a mode of treatment which has been several times successfully resorted to during labor—or the performance of laparo-hysterotomy. The diagnosis of these tumors by vaginal touch, or by bimanual examination, usually presents no difficulty. As in the case of fibroids of the body of the womb, a cervical fibroid may become pedunculated, and thus constitute the so-called fibrous polypus. The removal of tumors which have become pedunculated, either in the cervical canal or in the vagina, is generally quite easy. The pedicle, if thin, may be broken by torsion or divided with scissors; for the division of thick pedicles, Thomas's spoon-saw is an excellent instrument. Enucleation is necessary if interstitial tumors are to be removed, while those which are subperitoneal can only be reached by abdominal section.

POLYPI OF THE CERVIX.—While the cervix is very rarely the seat of fibroid tumors as compared with the body of the womb, this comparative exemption is reversed in regard to the presence of polypi, these being found very much more frequently in the former than in the latter situation.

Mucous Polypi.—These are local hypertrophies of the mucous membrane of the cervical canal. Different varieties are described, according as the hypertrophy affects particular elements of that tissue. Thus, if the glandular portion is specially involved, the polypus is glandular; if the tumor be chiefly formed by a retention cyst, it is called cystic; and, finally, a remarkable development of the bloodvessels, which are often varicose, causes the tumor to be called a vascular polypus. After the removal of a mucous polypus, examination with the microscope would prove its origin, racemose glands with cup-shaped epithelium showing conclusively that the growth had originated in the mucous membrane of the cervical canal. These tumors rarely attain the size of a hazel-nut, though, occasionally, a cystic polypus may be found much larger. That which has been described by Oldham, as a channeled polypus, may be as large or larger than a pigeon's egg; this tumor presents an uneven surface, marked by several openings, and has been compared to an hypertrophied tonsil; it contains numerous canals occupied by a viscid fluid. Most of these tumors can be removed by seizing them with polypus-forceps, and twisting the pedicle until it breaks; the base may then be touched with the tincture of the perchloride or with a solution of the persulphate of iron. If the tumor be large and have a broad base, removal may be effected with the wire-écraseur, or with the wire of the galvanic cautery.

Papillary Polypi.—Siredey and Danlos[1] describe under this name vegetations of a benign character developed at the surface of the os uteri. Their origin is often the same as the vulvar or vaginal vegetations, which in many cases are also present; they occur especially in women affected with chronic metritis or utero-vaginal blenorrhagia, or in the course of pregnancy. They cause profuse leucorrhœa, and sometimes hemorrhages after slight traumatisms, as from coition or digital examination.

Except in case of pregnancy, their removal is indicated. This may be effected by the same means as those advised for the ablation of mucous polypi.

MALIGNANT DISEASE OF THE CERVIX.—The two forms of malignant disease which may affect the neck of the uterus, are sarcoma and carcinoma. The former but rarely, the latter very frequently, originates in this part.

1. *Sarcoma.*—According to Bandl, three cases have been observed of œdematous spindle-celled sarcoma (*sarcoma hydropicum papillare*) of the vaginal portion of the cervix. As in the body of the womb, so sarcoma of the neck

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[1] Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques, tome xxxvii.

may occur in two forms, viz., either as a submucous growth, or as a diffuse growth originating in the mucous membrane. The diagnosis can only be made by means of the microscope, and the treatment is similar to that which will be presently described as appropriate to carcinoma of the cervix.

2. *Carcinoma.*—This stands second among the neoplasms of the uterus, myoma being first, and, in striking contrast with the latter, and with sarcoma, it begins in almost all cases in the neck rather than in the body of the womb. According to Schroeder's statistics, only two per cent. of uterine cancers affect the body first. The statistics of other writers make the difference still greater. Thus, according to Courty, the proportion is 1 to 429; according to Förster 1 to 420, and according to Goldschmidt, 1 to 900. The mortality from cancer of all organs taken together is greater in women than in men, and one-third of all cancers that are observed in the female sex are those of the uterus.

Etiology.—It is commonly held that the negress has a comparative exemption from cancer of the uterus, while peculiarly liable to myoma. The correctness of this statement may be doubted[1] until further investigations are made. Gusserow's table, including 2265 cases of cancer of the uterus, gives but two cases in persons under twenty years; from twenty to thirty years the number is almost precisely the same as after seventy years; the decade in which the disease has most frequently been seen is from forty to fifty, the next from fifty to sixty, and then from thirty to forty, while, finally, the period from sixty to seventy shows the least number of cases. It will thus be seen that there is a greater liability to the affection at certain ages. Frequent child-bearing seems to be a factor in the production of the disease, the fertility of women who suffer from this affection having been found to be slightly above the average. Schroeder says that his statistics, derived from the Polyclinic and from private practice, show that in the higher classes cancer of the uterus is comparatively rare, while in the lower classes, struggling for an existence, it is seen with alarming frequency. Emmet's views are in direct opposition to the results given by Schroeder. He says, "my own belief is that cancer of the uterus is to be found more frequently among the better classes than among the poorer ones, and that white women of this country are afflicted with this disease to a less degree than the women of older countries." Heredity may be observed in some cases, though according to Gusserow less frequently in this than when the disease occurs in other parts of the body. The tendency of professional opinion in recent years has been to attach less importance to this cause, and more and more to regard the disease as having a local origin. Emmet attaches great importance to laceration of the cervix as a factor in the development of epithelioma. Siredey and Danlos hold that cancer has an equal intensity in all conditions, saying that rich and poor, married and unmarried women, virgins and prostitutes, all are exposed to the disease, with nothing in the previous condition of health, or in the social state, permitting us to foresee a predisposition or an immunity.

Different Forms of the Disease.—Epithelioma and cylindrical-celled carcinoma are those most frequently met with. The existence of true schirrus of the cervix, doubted by some writers, is as strongly maintained by others. Schroeder makes the following classification: Superficial cancroid of the vaginal portion, carcinoma of the cervix, carcinoma of the cervical mucous membrane, and a fourth form, which, however, is very rare, and which is characterized by a superficial loss of substance, and by a tendency to extend upon the vaginal portion and on the adjacent parts of the vagina, especially upon the posterior vaginal vault. According to him, the third variety, carcinoma of the cervical mucous membrane, has its origin in the submucous connective tissue. Siredey and Danlos say that epithelial or superficial cancer of the neck of the womb originates either from the mucous membrane of the cervical cavity, *flat cancroid*, or from that which covers the mouth of the womb; the other varieties seem to originate beneath the mucous membrane in the form of infiltrated nodules, which grow and subsequently ulcerate at the surface. But the real point of origin, the anatomical element which undergoes the first change in the disease, is not certainly determined. Some make the epithelium intervene in all cases, the investing epithelium in cancroid, and the glandular epithelium in the deeper forms; others the interstitial connective tissue, submucous or intra-papillary. According to Ruge and Veit, the disease may originate in the connective tissue, in the papillæ, in the glandular epithelium, and exceptionally in the superficial epithelium. As observed by L. de Sinéty, none of the forms have a well-defined histological character. They may be found united, or the disease may pass from one to another. Thus the ulcerating form becomes vegetating, or ulceration may occur around papillary growths. Siredey and Danlos say that in exceptional cases the surface of the cancerous ulceration is formed by a tissue of normal appearance, all the infiltrated part having undergone gangrenous destruction, *the corroding ulcer* of the late Dr. John Clarke. On the other hand, West holds that Clarke's corroding ulcer differs from carcinoma in that there is no thickening, hardness, or deposit in its vicinity, and that it may continue for several years without causing any very formidable symptoms, while death takes place speedily and inevitably in ulcerated cancer.

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[1] This doubt is expressed in consequence of the fact that in the Dispensary service for Diseases of Women in the Jefferson Medical College Hospital, several cases of cancer of the womb occurring in negro women have been observed, probably quite as many, proportionally, as have been seen in white women.

Schroeder directs attention to two points in regard to the relation between the ages of subjects affected with cancer of the cervical mucous membrane and cancroid of the vaginal portion, and in regard to the direction of development. The former disease occurs more frequently in rather elderly women, the average age being forty-seven, while the average age for those suffering with cancroid is forty-two. Cancroid spreads toward the vagina; first appearing frequently on a single lip of the os uteri, or in other cases involving both, it rapidly grows until a mushroom-like or polypoid tumor more or less completely fills the upper part of the vagina, without the cervical mucous membrane being for some time affected. Moreover, extension to the vaginal mucous membrane is soon observed. On the other hand, cancer of the cervical mucous membrane is situated superficially under the cylindrical epithelium, and spreads chiefly in the submucous connective tissue; it transforms the cervical canal into a cavity with ulcerating walls; it extends early into the uterine cavity on account of the continuity of mucous membrane, and at last involves the uterine wall, while only at a later period is the mouth of the womb affected.

Symptoms and Progress of the Disease.—The beginning and progress of cancer of the uterus are in many cases very insidious, and the disease may have advanced to a state in which all attempts at cure are useless, before nature gives any cry of alarm. The three dominant symptoms are hemorrhage, pain, and offensive discharge. The *hemorrhage* most frequently manifests itself first as menorrhagia, and afterward as an occasional intermenstrual flow; in some cases it may be excited by coition, but it often occurs without obvious cause. In those women who have passed the menopause, an apparent return of menstruation is very frequently the first indication of cancer, and should always be regarded with suspicion. Mauriac mentions the case of a woman, seventy-five years old, who for more than two years had no indication of cancer of the womb except this false menstruation. In the first stages of the disease the hemorrhage arises from congestion caused by the neoplasm, but afterwards probably chiefly from ulceration.

"As a general rule the *pain* of the early stage of cancer is not severe; it is by no means constantly referred to the uterus, but is more often spoken of as backache, or pain in the loins, wearying by its constancy rather than by its severity."[1] It may accompany the first hemorrhages, but in many cases afterwards precedes the discharge of blood, and is relieved by it. As the disease advances the pain usually increases, and is especially liable to manifest itself at night; in very many cases it is described as a sharp, stabbing pain, while in others it seems to be a continual burning or tearing sensation. In some cases the severest suffering is caused by intercurrent attacks of limited peritonitis, as shown by exquisite tenderness, irritable stomach, and rise in temperature. Implication of the branches of the sacral plexus may, in the later stages, be the source of intense suffering. Extension of the disease to the bladder greatly increases the distress of the patient. "In the greater number of cases, the severest pain is experienced long before the patient's death, and the last months of existence, when all the evidences of the cancerous cachexia are most marked, and the strength is daily declining, are happily not in general agonized by intensity of suffering such as had been previously endured."[2] In very rare instances the patient may be comparatively free from pain during the entire course of the disease; according to West, it is in the epithelial form of the malady that such happy exemption more frequently occurs.

Early in the development of the papillomatous form of the disease, in some cases prior to the occurrence of hemorrhage, there are gushes or oozings of a serous fluid; the *discharge* is neither opaque nor glairy, and it only slightly stains, and scarcely stiffens, the undergarments upon which it falls. In other cases the discharge seems more like a profuse and thin leucorrhœal flow. More frequently this serous discharge succeeds the first hemorrhages, and intervenes between those which follow. After a time it becomes opaque, sero-sanguineous, like the washings of flesh; then it becomes purulent or ichorous, contains sometimes fragments of necrosed tissue and clots of blood, and is horribly offensive—the very odor oftentimes revealing the nature of the disease, and showing how far it has progressed. This offensive discharge is present at one time or another in almost all cases of malignant disease of the uterus.

The *constitutional symptoms* are usually well marked in the progress of the disease. "The cancerous cachexia,[3] which is absent in only some few instances of epithelial carcinoma where death takes place from pure loss of blood, is something more than the mere anæmia produced by hemorrhage, or by the exhaustion which follows protracted suffering. 'The fount of all the blood is touched corruptedly;' food does not nourish, the strength fails, the body wastes, the stomach refuses to perform its proper functions, nausea distresses the patient, or sickness wears her, and the red, raw, glazed, or aphthous tongue indicates but too clearly the state of the digestive mucous membrane, and explains the urgency of that thirst which drink cannot quench, which it is often scarcely able to allay." "The sleep is always disturbed and unrefreshing; opiates indeed may relieve the pain, but they often aggravate the other ailments; the patient feels too ill to sleep, or, if she dozes, the parched mouth and burning throat awake her, or else the sense of utter prostration and exhaustion, and the sufferer returns to consciousness with the feeling that but a little more and the sleep would have ended, as indeed it does not very rarely, in death."[1]

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[1] West, Diseases of Women.

[2] Ibid.

[3] Ibid.

In about one sixth of the cases of uterine cancer, according to L. de Sinèty, vesico-vaginal fistula results from the extension of the disease to the bladder; in a much smaller proportion of cases, and at a somewhat later period, recto-vaginal fistula occurs, and then the renal secretion and feces, mingled with vaginal and uterine discharges, are evacuated from a common cavity.

It is not uncommon when the first indications of cancer are observed, to find more or less immobility of the uterus, arising possibly from benign inflammation of the adjacent connective tissue; but after a time the cancerous disease spreads to parts and organs adjacent to the womb, so that ultimately in some cases this organ is but the centre of a cancerous mass, almost filling it may be the true pelvis. "Metastatic cancers are much less common; and their rarity, opposed to the relative frequency of the extension of the disease by continuity, is one of the best arguments that can be invoked for the admission of the predominance of cancroid or epithelioma over other forms of uterine cancer." (Gusserow.)

Bandl gives the average duration of uterine cancer as one year and a half, but there are cases in which the fatal issue is much longer delayed, from five to eleven years; especially slow are cases of carcinoma of the body of the uterus. Barker has reported a case in which death did not occur for twelve years and a half. The average duration, as given by Lebert, is a fraction over 16 months; as given by West, 17.3 months. In one case under the observation of the latter writer, death occurred within four months. As a rule, women with uterine cancer live longest when the disease occurs after the menopause.

Death may be caused by marasmus, hemorrhage, peritonitis, pulmonary complications, or embolism, or by uræmic accidents arising from obstruction of the ureters.

Diagnosis.—Usually when a case of cancer of the cervix first comes under professional observation, the disease presents such unequivocal symptoms that an error of diagnosis is impossible. The time for radical cure is almost always over when the unequivocal clinical signs of cancer are present.[2]

Beginning carcinoma of the vaginal portion is characterized by hard nodules, and by lessened mobility of the superjacent mucous membrane; these nodules are bluish or violet colored. The cancerous ulcer is excavated, irregular in form, with elevated and infiltrated borders.[3] According to Siredey and Danlos, benign is distinguished from malignant papilloma by the fact that in the former the papillomatous productions are more friable, bleed more readily, and are implanted upon a broader base. Nevertheless, they say that these differences are not always very pronounced, and that many times even the microscope does not furnish a conclusive diagnosis. The occurrence of papillomata in pregnancy, and in connection with similar vaginal and vulvar formations, would indicate their benign character. If the cancer be limited to the cervical canal, and the os be so contracted that examination is impossible, Bandl advises bilateral division of the cervix.

Treatment.—There is but one remedy for cancer of the cervix; removal of the entire diseased part. The different methods of amputating the cervix are given on page *g*73. If the disease has extended to the body of the uterus, the question of removal of the entire organ is presented.

Schroeder observes that the prognosis of the radical operation for carcinoma includes not only the mortality of the operation, but also that which results from a return of the disease. His statistics give the following results:

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[1] West, op. cit.

[2] Bandl.

[3] L. de Sinéty.

Of 105 cases of vaginal or supra-vaginal operation, 13 proved fatal, or 12.3 per cent.; of eight operated on by Freund's method (abdominal extirpation of the uterus), 5 were fatal, or 62 per cent.; of 32 cases of vaginal extirpation of the uterus, 9 were fatal, or 26 per cent. Of 47 women surviving vaginal or supra-vaginal amputation, 11, or 23 per cent., remained well after two years, while in 47 per cent. the disease had returned, and the condition of 30 per cent. was unknown. His results have been better with section followed by the actual cautery. Of 13 women thus operated on, 1 died, while at the end of two years, 5, or 42 per cent. of the remaining 12, continued well. Pawlik, whose statistics are also given by Schroeder, has had good results by using the galvano-cautery. Baker makes a funnel-shaped exsection of the cervix, and then applies the actual cautery. The late Marion Sims exsected with knife or scissors all the diseased tissue, then applied a tampon of cotton-wool, rendered styptic by being squeezed out of a solution of subsulphate of iron, one part of the salt to three of water, after which he thoroughly tamponed the vagina. After four or five days, the entire tampon having been removed, the conical excavation of the cervix was filled with small pieces of cotton-wool wet in a solution of chloride of zinc, five drachms of the chloride to one ounce of distilled water; the upper part of the vagina was then tamponed with cotton-wool saturated with a solution of bicarbonate of sodium. The vaginal packing was removed within two or three days, but that in the cervical cavity remained for four or five days.

Extirpation of the uterus for cancer is being so frequently done, at least abroad, and is, if not beginning to be more generally received as a legitimate operation, at least so much less decried than it was at first, that the vaginal method of its performance will be given.[1] Freund's method, or the removal by abdominal section, is attended by such great mortality that it is generally rejected unless in cases where the uterus is too large for ready removal through the vagina.

Where radical treatment, whether it be cervical amputation or uterine extirpation, is not resorted to, much may be done for the comfort of the patient, and probably for the prolongation of her life, by removing as far as possible the diseased tissue by means of the écraseur, galvano-cautery, or scissors, and then by the use of Simon's spoons. After this instrumental removal, the actual cautery may be applied, and then the excavated part may be filled with small tampons of cotton-wool which have been squeezed out of a solution of one part of bromine, two of iodine, three of crystallized carbolic acid, and four of alcohol, the adjacent parts of the vagina being protected from injury by a roll of cotton-wool dipped in a saturated solution of bicarbonate of sodium, and a similar tampon being applied directly beneath the caustic tampons in the cervix. Temporarily the disease is thus arrested, the hemorrhages and offensive discharges for a time cease, and the patient improves in condition. As soon as the growth reappears, the treatment may be repeated.

The treatment of the special symptoms of uterine cancer is important. The *offensive odor* of the discharge may be in large degree prevented by the use of injections of a solution of carbolic or salicylic acid, or of the potassic permanganate, by iodoform vaginal suppositories, or by thymol. *Hemorrhage* is to be met by the use of warm astringent injections; cold injections usually are very painful in cases of uterine cancer. Schroeder recommends pouring a solution of the chloride of iron through a milk-glass speculum directly upon the diseased mass. Slight hemorrhages may be arrested by vaginal suppositories of tannin. The *pain* will ultimately demand opium in some form, and opium given with a liberal hand. West advises giving at first the mildest form of narcotic, passing only by degrees, as each in turn ceases to be efficacious, to those which are more potent, and to the preparations of opium. Thus five grains each of henbane and of camphor, in the form of pills, are given at bedtime; when these lose their power, they may be supplemented by twenty minims of compound spirit of ether and fifteen of chloric ether. Indian hemp and chlorodyne may also be tried, before using opium; finally, when this must be used, the form will depend upon the peculiarities of the patient. Suppositories containing opium or morphia, or rectal injections containing one of the liquid preparations of opium, can often be usefully and conveniently used; where sleep is not secured by the opiate alone, chloral may be added. In case of suffering requiring instant relief, hypodermic injections of morphia are indicated, or even anæsthetic inhalations.

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[1] See page 740, *infra*.

Pregnancy occurring in Cases of Cancer of the Cervix.—The presence of even extensive cancerous disease of the cervix does not preclude the possibility of pregnancy, and the influence of this condition upon the progress of the disease varies in different cases. While in general that influence is injurious, hastening the evolution of the malady, in some cases no effect has been observed, while in a few the disease seems to have been retarded. The influence of the disease upon the pregnancy also varies in different cases. In a very few the pregnancy has been prolonged, the fœtus being dead. Two such cases have been reported by Menzies. In many abortion or premature labor occurs. In the majority labor comes on at the usual time, and in such the non-interruption of pregnancy is to be attributed to the fact that the disease has not extended to the internal os uteri, and possibly involves only the vaginal portion of the cervix, or that there has been an exemption from the hemorrhages often caused by the disease. The mortality in labor, or immediately after it, is for mothers more than fifty per cent.; the fœtal mortality in labor is more than sixty per cent.

The *treatment* of cancer of the cervix in a pregnant woman is determined by the seat of the disease, and by its progress. If it be limited to the vaginal portion, and is advancing, amputation of the cervix should at once be performed; this has several times been successfully done, and the pregnancy not interrupted. Even if the disease cannot be entirely removed, if there be severe hemorrhages, scraping away with Simon's spoons all the diseased tissue that can be reached, and cauterization, are indicated. When labor comes on, delivery may possibly occur without intervention, but in many cases incisions into the degenerated, undilatable cervix are necessary, followed in some instances by the application of the forceps; in other cases, the child being alive, delivery by the Cæsarean operation would be indicated, but if the child were dead craniotomy would be preferable. The induction of abortion or of premature labor, once urged by obstetricians, and especially by the late Dr. Robert Lee, is no longer regarded as the best practice in these cases.

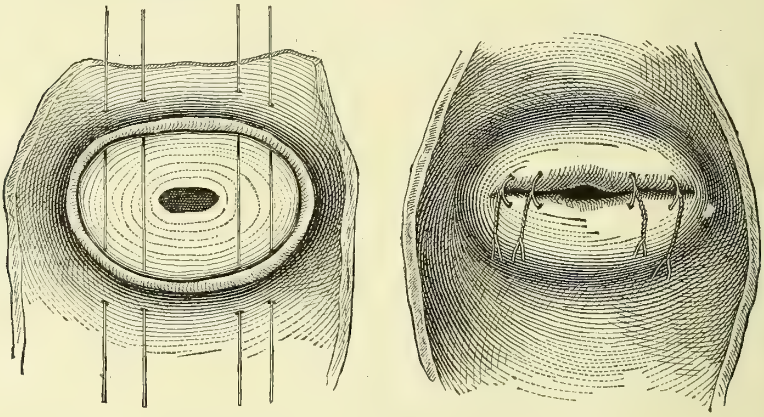
AMPUTATION OF THE CERVIX UTERI.

Amputation of the neck of the womb may be required by malignant disease or by hypertrophy, either congenital or acquired; the last condition is regarded by Emmet as rarely justifying the operation. The instruments with which the amputation may be effected are the scissors or bistoury, the chain or wire écraseur, the galvano-cautery—wire or knife—and finally the thermo-cautery. The selection should be governed by the special conditions of the case, and the surgeon will act most wisely by thus choosing, and not insisting that only one method must be always employed.

The amputation may be circular, flap, or conoidal; and it is obvious that the same means cannot be employed in these different varieties of the operation.

AMPUTATION BY BISTOURY OR SCISSORS.—*First Method.*—The patient occupies usually the dorso-sacral, but may be placed in the lateral position; the vagina should be thoroughly disinfected, especially if malignant disease be present. The cervix is exposed by Sims's or Simon's speculum, and seized with Museux's forceps or other suitable instrument, and an effort is then made by gentle and continuous traction to draw the organ to the vaginal mouth; this effort ought not to be made unless the uterus is mobile, nor unless there is entire absence of inflammation of the uterine ligaments and appendages. If there is room, a rubber ring may be placed on the cervix above the point of amputation, in order to prevent hemorrhage. While the neck is drawn forward, the posterior wall is divided by the bistoury, great care being taken to avoid injury to the peritoneum, and then the lateral walls, and lastly the anterior, are similarly cut through, the part incised being exposed by drawing the cervix to the opposite side. The rubber ring is gradually removed by cutting it, part at a time, with scissors. The hemorrhage may be arrested by hot-water injections, by astringent applications, by the actual cautery, or by the tampon. But it is evident that union by the first intention will be prevented by some of these means, and it is better, therefore, to employ hot-water injections, and then to introduce sutures.

Fig. 1411. Fig. 1412.



Amputation of the cervix uteri by Sims's method.

Dr. Sims[1] passed four silver sutures, two on each side of the canal of the cervix, through the cut edges of the vagina, antero-posteriorly; these sutures drew the vaginal mucous membrane over the stump of the cervix, covering it completely, but leaving a small opening in the centre to correspond with that of the cervical canal. The annexed illustrations show, first, the sutures as introduced, and secondly the same fastened, according to the method of Sims.

This method has been criticized by Hegar,[2] and more recently by Schwartz,[3] on the ground that blood and serum may collect behind the sutures, and thus prevent healing, while Thorburn[4] considers the employment of stitches a useless complication. Hegar advises the introduction of sutures in a radiating manner, so that all the circumference of the vaginal mucous membrane may be united to that of the cervical canal. The peculiarities of Hegar's method may be seen from the subjoined illustrations. (Figs. 1413, 1414.)

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[1] Uterine Surgery. [2] Op. cit.

[3] Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques, tome xxxvii.

[4] Practical Treatise on the Diseases of Women. London, 1885.

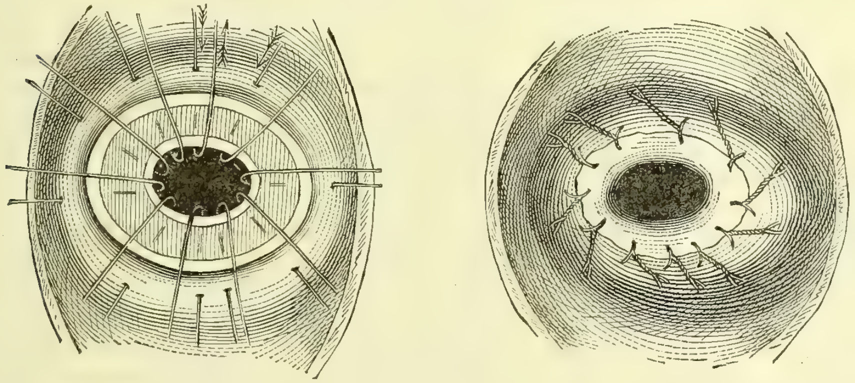


Fig. 1413. Fig. 1414.

Amputation of cervix uteri by Hegar's method.

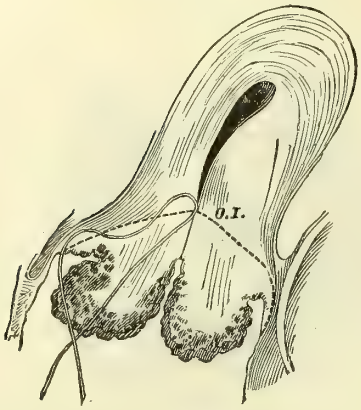
Hegar says that this suture gives excellent results when the tissues have a normal consistence, even in cases where the section of the cervix is flat and not excavated; but that if the walls of the neck are hard and rigid, it is scarcely possibly to depress the wound so as to obtain exact apposition of its borders.

Second Method.—The same preliminary steps as in the previous method having been adopted, the cervix is divided bilaterally, by means of straight scissors, to the point at which it is to be amputated, and then the anterior and posterior lips are successively removed. This method was that employed by Sims. A. R. Simpson has improved it by introducing wire sutures before the removal of the lips; three sutures pass antero-posteriorly through the cervical canal, just above the point of amputation, and then, after the operation, the loop of each is drawn down and divided, thus making the three into six sutures, which, when twisted, unite the mucous membrane of the canal with that of the external cervix; in addition, two or three sutures are introduced on each side. This method secures prompt hæmostasis. The sutures in all cases are removed in about ten days.

Marckwald's Method.—The same bilateral division of the cervix is employed as in the last-described operation, and then a wedge-shaped piece is excised from each lip, the free border of which forms the base of the wedge. There are thus made two flaps for each lip, and these are then united by sutures.

Conoid Amputation, or the Operation of Huguier.—This operation has been done for hypertrophy of the supra-vaginal cervix, but is now rarely resorted to, some authorities indeed asserting that it ought not to be employed in any case. The patient occupies the dorso-sacral position, and the operator introduces his left index finger into the rectum, and flexes it forwards, so as to indicate the lower attachment of the cervix to the rectum, and to avoid wounding the peritoneum. A semilunar incision, concave antero-superiorly, is then made at the level of the insertion of the vagina in the cervix, and by subsequent incision the tissues are divided obliquely, thus receding from the peritoneum, until the cervical canal is reached, and section of the posterior half of the cylinder is accomplished. Next the anterior half is similarly divided, the bladder being protected from injury by a straight sound which is held in it during this part of the operation. Hæmostasis was effected by Huguier by means of curved needles, the point of the needle being broken after its introduction, and a thread thrown around its two ends; another thread in the eye of the needle permitted the ready removal of the latter after some three or four days. Hæmostatic forceps have been suggested as a simpler and prompter means for the arrest of hemorrhage. Apart from any other objections, the method of Huguier is liable to be followed by atresia or stenosis of the cervical canal. The number[1] of operations done by Huguier, Chassaignac, and Gallard, was thirty-two; two patients died. One of Gallard's had a normal pregnancy after the operation. In hypertrophy of the intermediate portion of the cervix, an operation similar to that of Huguier's has been resorted to; of course it is attended with much less risk, since the disease involves only that portion of the cervix which is connected with the bladder, and there is, therefore, no danger of injury to the peritoneum. The accompanying illustration (Fig. 1415), from Schroeder, shows his method of performing a supra-vaginal amputation in cases of malignant disease of the cervix.

Fig. 1415.



Supra-vaginal amputation of cervix uteri by Schroeder's method, showing line of section and mode of introducing sutures; *o, i,* internal os uteri. (After Schroeder.)

Amputation with the Écraseur.—The methods of amputating the neck of the womb yet to be described, have, theoretically, this advantage, that all immediate hemorrhage is prevented, and, on the other hand, the disadvantage that primary healing is impossible, the process of cicatrization requiring some weeks; moreover, after some of them, very dangerous or even fatal secondary hemorrhage may occur. The special objections to the chain-écraseur are that it is difficult to apply the chain accurately to the place at which the section is to be made, and that it is liable to slip, so that too little of the diseased part will be removed; on the other hand, if the chain be too high, the bladder or the peritoneal cavity may be opened. To prevent slipping downward, Chassaignac passed a trocar through the cervix from behind forward above the place of amputation; the trocar was then withdrawn, but the canula left, and upon it the chain rested. More recently Verneuil[2] has used the canula for the transmission of a flexible bougie, to which two strong waxed threads are attached; these threads are used to draw through the cervix the chains of two écraseurs, by which the neck is amputated in two halves; or a single écraseur may be used, cutting off one-half first, and then the other. The section should be made very slowly; a single turn of the screw every thirty seconds, and toward the close every forty or fifty seconds, is sufficient. Verneuil directs that a two-per-cent. solution of carbolic acid should be gently thrown into the vagina until the fluid returns almost colorless. If hemorrhage occur, iced-water injections, or the thermo-cautery, may be used, and exceptionally the application of a sponge dipped in an antiseptic and astringent solution, for a few hours only. If the peritoneal *cul-de-sac* has been injured, sutures are to be applied, and if all the diseased tissue has not been removed

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[1] Annales de Gynécologie, Août, 1885.

[2] Archives Gén. de Médecine, 1884.

—the operation is supposed to be done for cancer—the affected parts are taken away with the curette, or with the thermo-cautery knife. The dressing advised by Verneuil is a compress of gauze made antiseptic with carbolic acid or iodoform, and changed when it becomes soiled.

The wire-rope écraseur is applied with less difficulty, and is therefore to be given the preference if either instrument is to be used; the majority of surgeons reject both, though amputation by the chain-écraseur is, according to Schwartz, one of the methods most generally employed in France.

Amputation with the Galvano-Cautery Wire or Knife.—A Sims's speculum made of vulcanite is preferable to a metallic one for exposure of the cervix, which, after exposure, is caught with a tenaculum or a Museux's forceps, no attempt, however, being made to draw it to the vulva; the platinum wire is then placed so as to encircle the neck at the point to be divided, and is tightened before making connection with the battery. Should the shape of the neck be such that the wire slips down, an ivory pin may be placed just below the place which it is to occupy, penetrating the neck from one side to the other.[1] The wire should not be heated above a dull-red heat, in order to avoid hemorrhage, and the current, therefore, must be frequently interrupted, and cold antiseptic irrigations of the vagina practised; the amputation requires several minutes, the time of course varying with the thickness of the structure to be divided. The eschar is detached in from one to two weeks, and antiseptic injections should be used before and after its detachment until perfect healing is accomplished. The possibility of dangerous bleeding should be borne in mind; profuse hemorrhage occurred during the operation in a case of Grünewaldt's, the patient dying, and Terrillon lost a patient from secondary hemorrhage eight days after the operation.

Amputation with the *galvanic knife* is a protracted operation, though it has the advantage of being bloodless or nearly so. The same frequent interruptions of the current and cold antiseptic vaginal injections are to be used during this operation, as were advised in amputation with the galvanic wire.

Hegar and Kaltenbach, rejecting both the écraseur and the galvano-cautery wire, speak of the latter as serving only for palliative or preparatory treatment in cancer, since it is usually impossible by it alone to remove all the diseased tissue; they also condemn it because of the possibility of primary or secondary hemorrhage, the impossibility of obtaining primary union, and the liability to stenosis or atresia at the position of the retracted cicatrix. Some of the same objections may be made to the use of the galvanic knife. Byrne, who has had a large experience with the galvano-cautery wire in amputation of the cancerous cervix, claims that if traction be made upon the neck during the operation, the stump will not be flat but funnel-shaped. A similar statement is made by Spiegelberg and Grünewald, who say, though making no reference to traction upon the cervix, that the wound made by the cautery wire is always found excavated in its central part, or, in other words, that this instrument makes a conoid amputation.

Amputation with the Thermo-Cautery Knife.—This instrument finds its most important, if not its only application in the operation for malignant disease of the cervix. Nevertheless, though more available than the galvanic knife, it is a coarser instrument, which is liable to destroy healthy along with diseased tissue, and the action of which cannot be so well limited; there is, moreover, greater liability to injury of the vagina or vulva in its introduction and withdrawal, and, in general, the suffering is greater unless an anæsthetic is used. While anæsthesia is usually advisable in these operations, there may be circumstances in an individual case which forbid it. Dr. Wilson, of Baltimore, has devised an ingenious thermo-cautery shield: It consists of an Éguisier's *irrigateur*, to which is attached a rubber tube conveying cold water from the irrigator to a hollow metal sheath which encircles the cautery knife; the water transmitted through this sheath prevents the burning of parts adjacent to the knife.

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[1] Thomas (Diseases of Women) has devised forceps for holding the cervix, and over this instrument the platinum loop may be readily slipped. One of the best plans for applying the loop is by using the instrument of Chéron, described in Le Blond's Chirurgie Gynécologique.

In general, both the galvanic and the thermic cautery are more used to supplement amputation of the cervix in malignant disease than for the operation itself; after amputation by other means, either of these may be successfully employed to remove diseased tissue in the cervical canal above the line of section.

Vaginal Extirpation of the Cancerous Uterus.

In describing this operation, the method of Schroeder will be followed.[1] "After exposure of the vagina, and drawing the cervix by means of Museux's forceps to the vaginal entrance, a circular incision is made in the vaginal vault. Now the bladder is completely separated from the uterus by means of the finger, and the peritoneum of Douglas's pouch is freely opened. By means of this wound the artificially retroflexed uterus is then drawn into the vagina by the finger, or by Museux's forceps, and, on the fingers inserted in the abdominal cavity as a guide, the peritoneum of the vesico-uterine excavation is incised. The uterus is now free anteriorly and posteriorly, and after cutting the lateral attachments, it can be removed as a whole. In this extirpation it is necessary to avoid hemorrhage as much as possible; this is most easily accomplished by using double ligatures closely applied to the sides of the uterus, and by being careful to ligate every large vessel as soon as it is cut. If advisable, the tubes and the ovaries are also removed. This large incision is best treated by inserting a thick drainage tube; the mucous membrane of the vagina may be sutured, which I prefer, or it may remain open."

As Schroeder says, total extirpation of the uterus should only be done when it is believed that all cancerous tissue can be removed by it, and when this result cannot be accomplished by any other means. This is particularly the case in carcinoma of the cervical mucous membrane, in which affection the mucous membrane of the uterine body is very soon involved. If the disease involve the cervix and the body, and if there be no implication of the neighboring organs, then total extirpation is proper; if the uterus be so large that it cannot be removed in this way, Freund's method may be adopted, although the patient has very few chances of recovery after that operation.

Elytrorraphy.

Elytrorraphy, or *Colporraphy*, is an operation by which the calibre of the vagina is lessened. If the operation be upon the anterior wall of the vagina, it is *anterior colporraphy*, and if upon the posterior wall, *posterior colporraphy;* when upon both walls, the two being partially united, it is *median colporraphy*, which may be transverse or longitudinal; and if restoration of the perineum and narrowing of the vulvar opening, or the latter alone, be done with posterior colporraphy, the perineum being entire, the operation is known as *colpo-perineorraphy.*

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[1] Handbuch der Krankheiten der weiblichen Geschlectsorgane, S. 302. Leipzig, 1884.

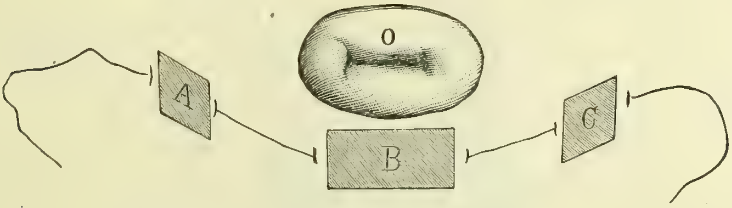
Anterior Colporraphy.—The operation consists in removing a portion of the mucous membrane of the anterior vaginal surface, and in stitching together the sides of the denuded part. Operators vary as to the size and form of the denuded surface, though in regard to the latter, the ellipse, or some modification of it, is that which has been usually selected.

The operation is indicated in cases of otherwise incurable prolapsus of the anterior vaginal wall, cystocele being almost always present, and also more or less descent of the uterus. In most cases it is simply preliminary to posterior colporraphy.

Three operations, Emmet's, Hegar's, and Schroeder's, will be described.

Emmet's Anterior Colporraphy.—The patient at first lies upon her back, and the uterus is anteverted, and held in anteversion by means of a sponge probang; she is now turned upon her left side, and the anterior vaginal wall is exposed with a Sims's speculum. With a tenaculum in each hand, the operator finds two points which can be brought together with slight tension, one on each side of the cervix and about half an inch from it, and a little behind the line of the anterior lip; each point is the centre of a half-inch square, which is then denuded. Next, a strip of vaginal mucous membrane, an inch long and half an inch broad, is removed from in front of the uterus. A needle threaded with silk carries a silver wire beneath the freshened surfaces, and when the wire is twisted the three are brought together. In the subjoined illustration A and C represent the lateral denudations, and B the central one; the twisted wire brings A and C in contact with B.

Fig. 1416.



Anterior colporraphy. (Emmet's method.)

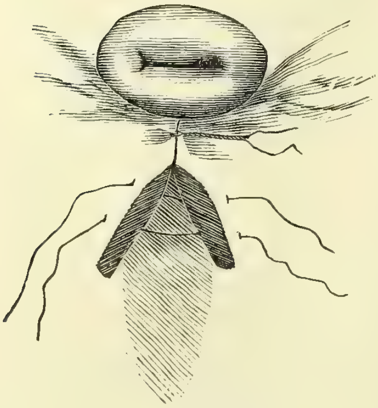
Two longitudinal folds are formed upon the vaginal wall by bringing these points together, and they inclose a space having somewhat the form of an elongated ellipse, as is seen in the next illustration (Fig. 1417).

The next step is to denude the summits of these folds, avoiding the loss of blood, if thought desirable, by freshening only half an inch at a time, and then stitching this before denuding any more; four or five sutures are required for each inch, and they should not produce undue tension; the folds are lost at the lower portion of the vagina, and there of course the denudation and stitching also end. A self-retaining sigmoid catheter is introduced, or, if this cannot be borne, the urine is evacuated every few hours; the stitches are removed in eight or ten days.

Hegar's Method.—The form of the denudation is that of an ellipse, narrowed below, and blunt or widened above; the subjoined diagram (Fig. 1418) shows the freshened surface with the sutures introduced.

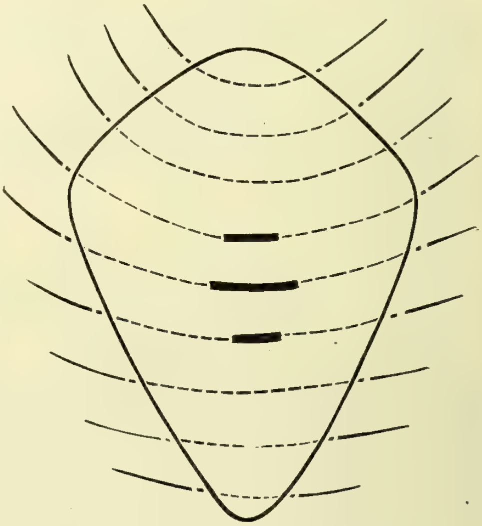
The patient is placed in the lithotomy or in the dorso-sacral position, but an anæsthetic is not used unless she is very sensitive and restless. Four assistants are required, two to hold the lower limbs and aid in exposing the field of operation, a third to hand instruments, and a fourth to sponge and irrigate the parts. The instruments are a small convex bistoury, thin-bladed scissors curved upon their face, tenaculum-forceps and hæmostatic forceps, needles, a needle-holder, straight scissors, sponges and sponge-holder, wire and silk, and a catheter. Beside these, a strong forceps, or a suitable clamp, to hold the vaginal mucous membrane after it has been lifted up, and a probe-pointed bistoury, will be needed. The first step is to lift up by means of two or three forceps a longitudinal fold upon the anterior vaginal wall; the highest point at which one of the forceps is placed is about one centimetre from the anterior lip of the uterus, and the lowest, for another, is three centimetres from the urethral orifice. Drawing on these instruments, the fold is so raised that a clamp can be applied in a direction parallel to its course, and for this purpose the forceps of Krassowski, that of Hegar, or the apparatus of Chéron, may be used. The instrument is not applied to the base, but ought to approach somewhat the crest of the fold. The sutures are now passed from one side to the other, about a centimetre below the clamp; the next step is to excise the fold with a bistoury, the incision passing between the sutures and the clamp; the threads are fastened, and then superficial sutures are introduced to secure firm closure of the wound. Care must be taken to prevent any blood from remaining between its lips; if any is found it is pressed out, and if there are bleeding points between the sutures, the hemorrhage is to be arrested by the introduction of deep stitches.

Fig. 1417.



Anterior colporraphy; the sutures adjusted. (Emmet's method.)

Fig. 1418.



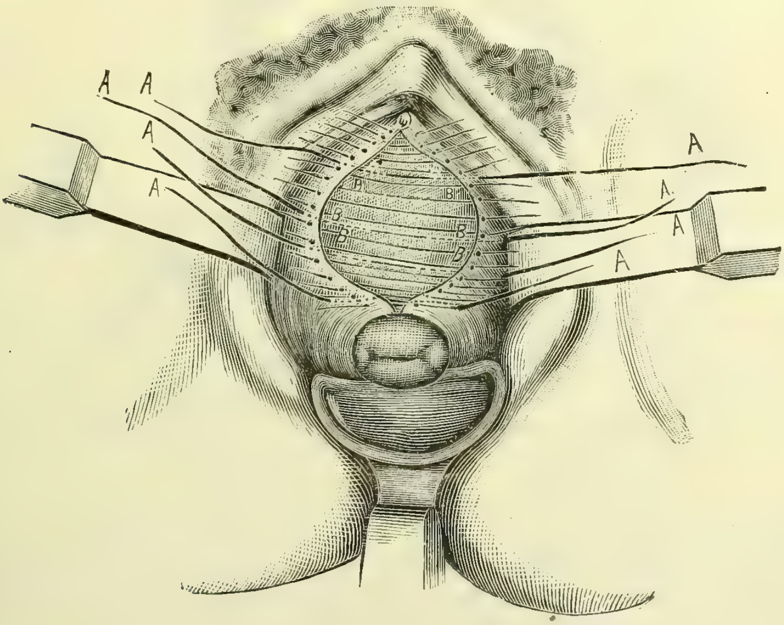
Anterior colporraphy. (Hegar's method.)

An objection to this method is the danger of excising part of the wall of the bladder. Hegar says that this accident has never occurred to him. To guard against its occurrence, a catheter may be passed into the bladder before the clamp is applied, in order to learn the thickness of the vesico-vaginal wall; generally, when the fold is lifted up, one can recognize the vaginal, and beneath it the vesical wall; further, in passing the needles, the catheter being retained in the bladder, the metallic sound of the former striking against the latter may be recognized.

The old method of denuding must, however, be resorted to, if the vesico-vaginal wall is very thin and atrophied. Hegar uses the bistoury, but Simon preferred scissors; Bischoff, after having circumscribed the tissues to be removed, seizes the flap, and separates it by drawing on it with his fingers. Whatever method is used, after the flap has been removed the surface should be levelled, all islands of projecting tissue being trimmed away with scissors. If during the denuding abundant hemorrhage occurs, the hæmostatic forceps or even the ligature may be used, the final hæmostasis being secured by carefully applied sutures. When only anterior colporraphy is practised, silk sutures may be used; but if posterior colporraphy also, silver wire is a better material, for the stitches must remain some time.

Schroeder's Method.[1]—Schroeder regards it as important that the space denuded shall not be too small. Below, it begins at the mouth of the urethra, and it extends above to the anterior lip of the uterus. He thinks it more satisfactory if the part removed be torn from its base, as there are then no islands of mucous membrane left. Or the denudation may be effected by introducing a long flat knife under the edge of the incised mucous membrane, and cutting each way; after completing this dissection, the surface is to be levelled with scissors. Then the sutures are introduced; some of them are superficial, others deep—of the latter only three are usually required; the deep sutures are to prevent the formation of pockets in which blood or wound-secretions may collect. According to Werth's suggestion, catgut may be used for the deep stitches, and it is very convenient, for the perfect adaptation of the

Fig. 1419.



Anterior colporraphy. (Schroeder's method.)

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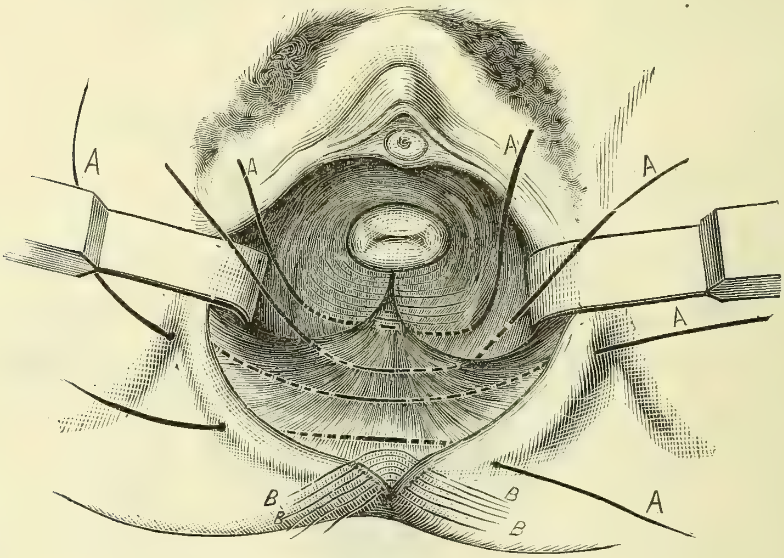
[1] Op. cit.

wounded surfaces, to use the continuous catgut suture. Quite recently Schroeder[1] has spoken still more favorably of the latter; he also says that, in order to prevent disturbance of the wound by the movements of the bladder, he introduces after the operation a tampon of iodoform-cotton into the vagina. The preceding diagram (Fig. 1419) shows the denudation as done by Schroeder, with the superficial and deep sutures in place.

Posterior Colporraphy.—The operation is similar to that upon the anterior vaginal wall, though operators differ as to the form and as to the extent of the denuded surfaces; in regard to the former, the ellipse or some modification of it is usually selected. Hegar, as in his anterior colporraphy, uses the clamp; the risk of opening Douglass's *cul-de-sac* is, according to his experience, slight, this accident having occurred to him but once, and then no serious result having followed. Schroeder's operation is shown in the subjoined illustration. It consists in freshening a part of the posterior vaginal wall, and a large part of the vaginal entrance; the denudation above extends to a centimetre from the highest part of the vaginal vault; deep and superficial sutures are used, as in anterior colporraphy; the deep stitches may be of catgut, and this material may also be used as a continuous suture.

Fig. 1420.



Posterior colporraphy. (Schroeder's method.)

Emmet's Method.—A paper by Dr. Emmet, entitled A Study of Perineal Laceration, with a New Method for its Proper Repair, was read before the American Gynæcological Society in 1883, and created no little discussion. A misapprehension of the purpose and character of the operation was manifest at the time that the paper was read, and probably even yet exists in some degree. As this operation is upon the posterior wall of the vagina, and narrows the canal, at least at its lower part, it may be termed a posterior colporraphy. The vaginal contraction which it causes is easily explained if we regard the injury requiring it as resulting from tearing of muscular tissue rather than of pelvic and perineal fasciæ. Budin[1] holds that the fibres of the levator ani, rather than the covering fasciæ, are the parts which have been injured. He remarks that "the comparison of the mouth of a purse closed by a cord, is more readily comprehended with retractile and contractile muscular fibres than with fascial fibrous tissue. One also better understands the great distention which the bands encircling the vagina can undergo in labor, if the resistance is due not to the tissue of fasciæ, but to muscular fibres."

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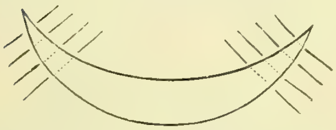
[1] Centralblatt für Gynäkologie, 1885.

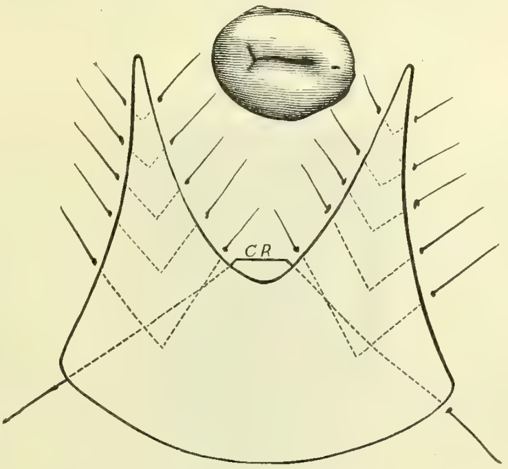
The patient lies upon her back; the lower limbs, strongly flexed upon the abdomen, are held by an assistant on each side; and the hips are brought to the foot of the table. The assistants separate the labia. The operator's first step is to seize with a tenaculum the crest of the presenting rectocele, or the posterior wall of the vagina, at a point where it can be drawn forward, without undue traction, to near the entrance of the urethra; the instrument is then held by an assistant. Next, the operator inserts a tenaculum into the lowest hymeneal caruncle on each side; bringing the three tenacula together, the vaginal canal will be found reduced in size, the perineum will have been apparently drawn up toward the arch of the pubis, and the tissues at the previously gaping outlet will have been rolled in until the vaginal entrance is no larger than that of a woman who has not given birth to a child at term. The three points held by the tenacula form across the vagina, and just within the vulva, a sulcus the ridges of which must be denuded and united with sutures. The annexed illustration (Fig. 1421) shows the denuded surfaces, with four of the sutures introduced on each side. In many cases the denudation has less of a crescent form than is represented in the above illustration. Dr. Joseph Price,[2] to whom I am indebted for the next illustration, says that the denudation only roughly corresponds with a crescent, whose convexity is the boundary of the skin and mucous membrane of the vulva, while its concavity is at the summit of the rectocele, and its cusps extend up the lateral deep sulci and posterior wall of the vagina. The sides of each sulcus are stitched together, the stitches being so introduced as to lift up the tissues toward the apex of the triangle, and hence they do not pass directly across from side to side, but the needle, after entering at one side in the undenuded tissue, passes somewhat obliquely to the middle of the freshened surface, then is re-introduced, and is given a course nearly at a right angle to that which it first took, until it

Fig. 1421.



Posterior colporraphy. (Emmet's method.)

Fig. 1422.



Posterior colporraphy by Emmet's method. (After Price.)

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[1] Progrès Médical, Août, 1881.

[2] See a valuable paper read by Dr. Price before the Philadelphia County Medical Society, June 24, 1885.

emerges at a suitable distance from the margin of the other side; a stitch is then passed from one to the other labium, passing at its middle through the crest of the rectocele. The sutures may be of silkworm-gut, and secured by compressed shot; Emmet, however, prefers silver wire.

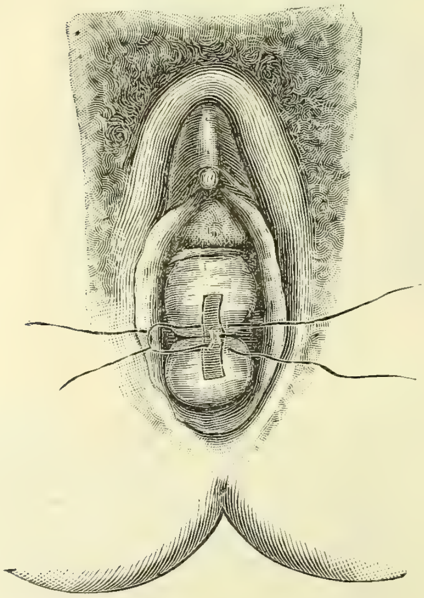
Median Colporraphy.—In this operation the vagina is narrowed by attaching a part of the anterior to a part of the posterior wall; the vagina is thus partially made double. Hegar credits Spiegelberg with having first done this operation; he sutured the lowest points of the anterior to the upper part of the posterior wall. Le Fort subsequently adopted a similar method.

Le Fort's Operation.—This is the method usually followed, and it consists in denuding in the median line upon the anterior, and then upon the posterior wall of the vagina—vagina and uterus both being prolapsed—a surface two centimetres broad by four or five in length, and then, after reducing the displacement, in stitching the two surfaces together. If silver wire is used the ends should be left long, so that they may be removed by moderate traction after the surfaces have firmly united; they are generally loosened from the tenth to the twentieth day. The use of catgut is proposed by Eustache.

The accompanying illustration (Fig. 1423) shows the denuded surfaces, one of the sutures having been introduced.

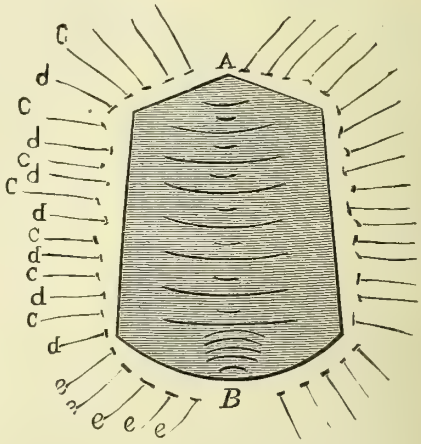
Colpo-perineorraphy.—This operation not merely lessens the calibre of the vagina, but also lessens the vulvar opening—prolonging the perineum so as to prevent vaginal and uterine prolapse.

Fig. 1423.



Median colporraphy. (Le Fort's method.)

Fig. 1424.



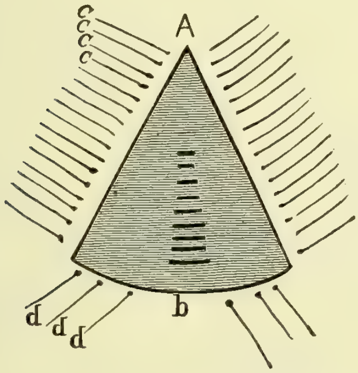
Colpo-perineorraphy. (Simon's method.)

In the posterior colporraphy of Schroeder, it is readily seen by the illustration that the perineum is involved as well as the posterior vaginal wall, the extent of the former being increased, so that strictly speaking the operation is a colpo-perineorraphy.

Different forms have been given to the vaginal and vulvar denudation by different operators. The annexed illustrations (Figs. 1424, 1425) show those of Simon and of Hegar, the surfaces not only having been freshened, but the vaginal sutures, superficial and deep stitches alternating, and the perineal sutures, having been introduced.

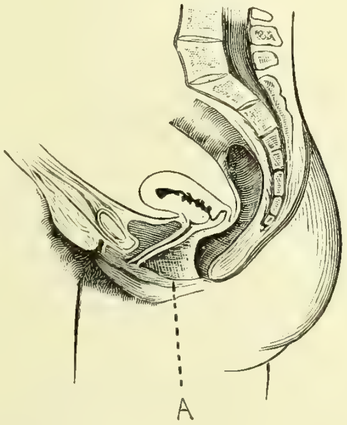
The following illustration (Fig. 1426) shows the increase in extent of the perineum from Schroeder's operation, already described; the upper end of the line A, shows the anterior boundary of the original perineum, and the beginning of the added portion.

Fig. 1425.



Colpo-perineorraphy. (Hegar's method.)

Fig. 1426.



Restoration of perineum by Schroeder's method.

The form of denudation recommended by Hegar is a triangle. Usually this triangle has a base of six or seven centimetres, and its height is seven centimetres; but if the prolapsus be very great, the base of the triangle may be eight centimetres, and its height even nine centimetres. Tenaculum-forceps are applied at the apex and at the sides of the triangular flap to be removed, lateral incisions are made, and then the dissection begins at the apex; after the upper portion is free, traction may be made upon it, the separation being completed partly by tearing, and partly by cutting with the bistoury. After the removal of the flap, the surface from which it was detached is made even by the scissors. The removal of the flap can be done in five or ten minutes, and the more quickly this is done the less is the hemorrhage, which often ceases when the flap is completely removed. The vaginal sutures, alternately deep and superficial, are of silver wire, and the perineal sutures of silk; it is probable that both may be usefully replaced by catgut.

Episiorraphy.

Episiorraphy is an operation designed to partially occlude the vulvar orifice in order to prevent prolapsus of the vagina or of the uterus. A horseshoe-shaped denudation is made of the lower two-thirds of the vulvar orifice—some surgeons remove the nymphæ—and the freshened surfaces are stitched together. Anger has varied the ordinary method by not removing the flap; he dissects it from almost all the circumference of the vaginal entrance, beginning near the urethra, but leaves it attached above, so as to make a partial diaphragm in the form of a crescent; three sets of sutures—one in the vagina connecting the free margins of the flap, another, a deep set, extending to its base, and finally a superficial set—are then introduced. Episiorraphy is now rarely resorted to. In some cases perineoplasty is supplemented by a partial episiorraphy, and then the operation is an *episio-perineoplasty.*

VAGINISMUS; REFLEX CRAMP OF THE MUSCLES OF THE PELVIC FLOOR.

The profession is indebted to the late Dr. Marion Sims for the first description of an affection of women which he called vaginismus, although brief reports of individual cases of the disorder had been previously given; Burns[1] had referred to the disease, and had advised surgical treatment not very unlike a part of that subsequently directed by Dr. Sims. The latter's paper describing this affection was presented to the London Obstetrical Society in 1862. He defines vaginismus as an involuntary spasmodic closure of the mouth of the vagina, attended with such supersensitiveness as to form a complete barrier to coition; inflammation may be present, but the disorder does not depend upon it; the gentlest touch with the finger, a probe, or a feather, produces agony. It is thus seen that in vaginismus, as originally described by Dr. Sims, the essential ideas included were pain and spasmodic contraction of the entrance to the vagina. It is a mistake, however, to regard the affection as limited to the muscular structure concerned in closing the mouth of the vagina; moreover, there may be a vaginismus which is not painful. According to Luschka, the constrictor vaginæ only indirectly lessens the vaginal entrance: it is a double, flat muscle, ascending externally to the bulb of the vestibule, and its two halves uniting partly above, partly below the clitoris; it has little importance as a constrictor, but its action is to cause engorgement of the bulb, and to draw the two parts toward each other. The real sphincter of the vagina, according to Luschka, "is a ring-like, flat muscle lying immediately behind the bulb, encircling the lower part of the vagina and also inclosing the urethra, so that it might be appropriately called the *musculus sphincter vaginæ atque urethræ.*"

But in addition to the contraction of these muscles in vaginismus, the external anal sphincter, the transverse perineal, and the levator ani may also be concerned; indeed, in one form of the disorder only the latter muscle, or even a portion of it, may be affected. According to Beigel, no constriction of the vaginal canal can be directly caused by the contraction of the levator ani, but only from its then elevating the anus. Nevertheless, Hildebrandt's[2] explanation of the narrowing of the superior part of the vagina by the action of this muscle, is generally accepted, and has been recently shown by Henrichsen[3] to rest upon a correct anatomical basis, and to be confirmed by clinical facts.

There are thus two forms of vaginismus, the one at the vaginal orifice, and the other four or five centimetres above; the one *vaginismus inferior*, the other *vaginismus superior.* The one prevents the introduction of the penis, the speculum, or even a finger; the other may act in the same manner, or, on the other hand, it may not hinder the entrance, but may prevent the withdrawal of the penis. The condition last mentioned has been described by Hildebrandt, but it is an error to regard him as having first observed it. Several examples of this accident are given by Schurigius,[1] quoted from previous authors, one of these authors describing it as "a spasmodic affection of the female genitals." Diemerbroeck[2] mentions an instance where the separation was thus effected: *quem nexum advocatus medicus affusione aquæ frigidæ protinus dissolverat.* Budin[3] has met with instances in which this contraction of the levator ani was under the control of the will, so that those having this power could voluntarily prevent either the introduction or the withdrawal of the virile member.

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[1] In speaking of the vaginal sphincter, he says (Principles of Midwifery, seventh edition, p. 41. London, 1828): "This sphincter is sometimes spasmodically contracted, and the nerves so sensible that pain is felt in coitu, and at last some degree of permanent circular stricture is produced. The cure in all stages is division in a lateral direction of the affected parts." Huguier, in 1834, described spasmodic contracture of the vaginal sphincter.

[2] Billroth, Handbuch der Frauenkrankheiten.

[3] Strictur der Scheiden-gewölbes, bewirkt durch Krampf der Musculus Levator Ani (Archiv für Gynäkologie, 1884).

Spasmodic contraction at the entrance of the vagina is that form which is much the more frequent. An examination, which generally requires an anæsthetic, will in most cases discover some inflammation or excoriation of the external surface of the hymen, of the carunculæ myrtiformes, if the hymen has been ruptured, or of adjacent parts; the disease may result from a vulvar or an anal fissure, from a sensitive tumor of the urinary meatus, or from vaginitis. Even in some cases where no local lesion is discovered, we have the right, as suggested by L. de Sinéty, to suppose that such a lesion has disappeared, and that the contraction which it caused has remained. Veit has directed attention to metritis, uterine displacements, and oöphoritis, as causes of the affection. Hildebrandt connects the place of the lesion with that of the contraction; thus affections of the vulva lead to contraction of the vaginal sphincter, and those of the uterus and ovaries to contraction of the levator ani.

This disorder, though it may occur in a woman who has borne one or more children, is most frequently met with in newly-married women, and in such cases usually results from bungling, or brutal, fruitless attempts at coition. In some cases the difficulty arises from the form of the vulvar orifice, or from the perineum being prolonged so far anteriorly that the orifice, when the subject is recumbent, is in a horizontal plane, and that the penis thus impinges upon the fourchette or navicular fossa, or upon the urethral opening; in some cases the urethra has been thus dilated, and coitus has occurred through that canal—one patient complaining that a discharge of urine always followed coition. In any case the parts are bruised, and thence the vaginismus.

While in the great majority of cases a local lesion, past or present, explains the disorder, there are some few in which it cannot be attributed to such a cause, and in these it is called neuralgic; instances of this kind are found most frequently in hysterical persons. L. de Sinéty observes that, when the disturbance of local sensibility depends upon a general neurosis, it is very rare that the hyperæsthesia is manifested only at the vulvar region, and that painful points are not found at other parts of the body, particularly at the seventh and eighth dorsal vertebræ. Beigel mentions a case of facial neuralgia, alternating with a vulvo-vaginal neuralgia, in a woman who had never presented hysteric symptoms.

Patients suffering with vaginismus are usually sterile; nevertheless, conception may occur without intromission having been accomplished; Packard and Von Preusschen each gives an instance of this kind. Among the consequences of vaginismus, in addition to the spasmodic and painful contraction of the muscles of the pelvic floor, and the consequent rectal and vesical tenesmus,[1] there may be sleeplessness, hysterical symptoms, mental depression, and disorder of the general nutrition.

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[1] Gynæcologia Historico-Medica. 1730.
[2] Anatom. Corp. Human., lib. i. 1687.
[3] Le Progrès Médical, 1881.

Obviously the first thing in the treatment of a case of vaginismus is to give the patient rest from all attempts at sexual intercourse. Next, where possible, to remove the cause of the spasmodic contraction. Thus, a sensitive tumor of the urinary meatus requires excision, vulvar or anal fissures are to be appropriately treated, a resisting hymen is to be incised, while an inflamed caruncle, the hymen having been ruptured, is to be removed; if the latter be done, it is advised to stitch together the borders of the wound so that healing may occur by first intention, and not by the formation of cicatricial tissue, the presence of which may produce as much mischief as the caruncle, or even more. Raw and excoriated surfaces heal readily under the application of a weak solution of nitrate of silver, of iodoform, or of lotions of lead-water, with warm hip-baths. All local lesions having been removed, or none having been found, the best means for the relief of the hyperæsthetic condition is the use of a solution of muriate of cocaine (from four to eight per cent.), applied with a camel's-hair pencil to the sensitive parts. In many cases no other treatment will be required; in others surgical means for the relief of the contraction will be needed. These are, chiefly, gradual dilatation of the constricting muscles, abrupt dilatation or rupture, and incision. The first is done by the use of a series of speculums, or dilators, increasing from day to day the size of the dilating body as well as the time of its retention, the latter varying from a few minutes to an hour or more. Forced dilatation, similar to that used in anal fissure, may be employed, the patient being anæsthetized, by introducing two or three fingers into the vagina, and then widely separating them, or by similarly introducing one of the valvular uterine speculums—bivalve, trivalve, or quadrivalve—closed, and then opening and abruptly withdrawing it. Section of the pudic nerve was advised by the late Sir James Y. Simpson, and incision of the perineal body by Savage, while several authors have recommended subcutaneous division of the sphincter. Dr. Sims's method was described by him as follows:—

> "Placing the patient (etherized) on the back, with the thighs well flexed over the abdomen, the orifice of the vagina is to be forcibly dilated by fingers or instrument. Then seize the hymeneal membrane with a delicate pair of lock-forceps just at its junction with the urethra on the left side, and, putting it on the stretch, clip with properly curved scissors till the whole is removed in one continuous piece. Then pass the index and middle fingers of the left hand into the vagina, separate them laterally, so as to dilate it as widely as possible, putting the fourchette on the stretch; then with a scalpel cut through the vaginal tissue on one side of the mesial line, from above downward, terminating at the raphe of the perineum. This cut forms one side of a Y. Then pass the knife again into the vagina, still dilating with the fingers as before, and cut superficially in like manner on the opposite side from above downward, uniting the two incisions at or near the raphe, and prolonging them quite to the perineal integument. Or these vaginal incisions may be made one on each side of the raphe and parallel with it, terminating a third of an inch or more apart, on the perineal surface. The bleeding, usually trifling, is arrested by the introduction of the vaginal plug. I have had two cases where it was necessary to resort to the iron-cotton tampon for twenty-four hours. Generally the dilator is introduced at once. It is made usually of glass, sometimes of metal or ivory. I prefer glass because it is easily kept clean, and, being transparent, we can see the cut surface, and, indeed, the whole vagina, without removing it. Its introduction is attended with a sense of soreness, but with none of the peculiar, agonizing suffering so characteristic of the original disease."

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[1] Sims says that in some instances the sphincter ani feels almost as hard as a ball of ivory; one of his patients supposed it to be a tumor that would require exsection.

The dilator is secured in position by a T-bandage, and is worn for two or three hours in the morning, and again in the afternoon or evening; it is used for two or three weeks, or longer, or till the parts are entirely healed and sensitiveness gone.

The objection to a glass dilator is that sometimes the instrument may undergo spontaneous fracture while in the vagina, greatly to the dismay of the patient, and that, even if no injury be done, the removal of the fragments may be somewhat difficult; an accident of this kind occurred to a patient under my own care.

Dr. Emmet, who regards an operation as rarely necessary, performs it as follows: The patient is placed on the back, with the limbs drawn up; after etherization a speculum is introduced under the arch of the pubis, so as to bring the posterior wall of the vagina into view. The index finger is introduced within the anus, and the sphincter is forced up against the posterior wall of the vagina. It is then easy to divide with scissors the fibres encircling the vagina on each side, just within the fourchette, and about three-quarters of an inch apart. This does not allow a prolapsus of the vaginal wall, but permits an equal extent of dilatation of the outlet by the glass plug.

COCCYGODYNIA.

Coccygodynia, or coccyalgia, is the name given to a severe pain situated in the coccygeal region, and aggravated or excited by pressure or by movement of the coccygeal bones. The late Dr. J. C. Nott, of New York, and formerly of Mobile, is credited with having first directed professional attention to this subject.

Generally regarded as belonging exclusively to the female sex, though this is denied apparently with sound reason by Worms, coccygodynia is most frequently seen during the period of sexual activity; but two cases are mentioned by Hörschelman in which the subjects were between four and five years old. Though generally met with in the married, yet Courty and Nélaton mention its occurrence in virgins.

A fall or blow upon the coccyx may cause the disease; it has been caused by riding on horseback (Scanzoni), and by exposure to cold, as in a patient of Courty's, who was accustomed to lie in bed with her uncovered hips pressing against the wall, and as in another case in which it was induced by sitting on a wet cushion while riding in a carriage. Seeligmüller had a most obstinate case of coccyalgia in a woman upon whose shoulders a cow sprang, crushing her to the ground. But the great majority of cases originate in labor, either natural or instrumental. In some cases the bones of the coccyx are found dislocated or fractured; in others, caries or osteomalacia may be present, or there may be periostitis. Diseases of the pelvic organs, such as uterine displacements and inflammation, ovarian disease, and peri-uterine inflammation, may, according to some writers, also be causes of this affection. In rare cases it may be a pure neurosis, a neuralgia of the coccygeal plexus.

The coccyx presents great sensibility if pressed on either externally or through the rectum; the subject of coccygodynia may suffer in walking, in sitting, or in lying on the back; defecation is usually attended with great suffering, and in some cases the sexual relations become impossible.

The disease is usually chronic, and is often exceedingly rebellious to treatment, while again, in an acute case, it may disappear, permanently or only temporarily, without reference to treatment. Various local remedies have been resorted to, such as counter-irritation, the endermic or hypodermic use of morphia, the hypodermic injection of hot water, and the application of tincture of aconite root; in some cases, probably, the use of muriate of cocaine would be successful. Seeligmüller speaks very highly of electric treatment; he makes use of Faradization, the metal electrode being applied to the cervical portion, and the sponge electrode to the vicinity of the coccyx.

The surgical treatment includes two methods: one is the division of the fibrous attachments of muscles and tendons to the coccyx; the other is the extirpation of a part, or the whole, of the bone. The former, though priority is usually attributed to the late Sir James Y. Simpson, was first done, according to Seeligmüller, by Peter Krukenberg, in Halle. As to the method of operating, Simpson directed that a tenotomy knife should be introduced under the skin, at a short distance from the coccyx, passed along the posterior aspect of the bone, and then turned so as to divide the muscular and tendinous attachments, first on one side, then on the other, and finally all around the tip of the bone. This operation has not proved invariably successful. (Gosselin, Nélaton, Thomas.)

Extirpation of the whole, or of part, of the coccyx, for this affection, was first done by Nott. His method was, after introducing the left index finger into the rectum so as to press the coccyx firmly outward, to make an incision with a short, strong scalpel in the median line down to the bone, extending a little below the tip and above the articulation. The attachments of the bone were divided on each side, then the knife was passed through the articulation so as to completely separate the bones, the left hand was disengaged, the upper end of the detached bone was seized with Fergusson's lion-jawed forceps and pulled firmly outward, while the knife was used to complete the separation.

Usually the hemorrhage is not great after extirpation of the coccyx. Lamb, however, reports two cases in which there was such considerable arterial bleeding that a tampon of tarred jute was pushed into the cavity.[1]

STERILITY.

If a woman in the reproductive period of life has no living or viable children, notwithstanding frequent cohabitation, normal spermatozoids being discharged into the vagina, she is sterile. As in the great majority of cases the first child is born within eighteen months after the beginning of married life, a wife who remains two years childless is called sterile; but this is only *relative* sterility, for she may reproduce subsequently to the first two years. If a woman in the conditions first stated, has no child, the sterility is called *congenital;* but it is *acquired* if, after having borne one or more children, she remains childless for three years. Congenital is nearly twice as frequent as acquired sterility.

According to Matthews Duncan, one marriage in ten in Great Britain is sterile. S. W. Gross's statistics, though including too small a number of cases to be conclusive, show that in one out of six sterile marriages the husband is at fault, while L. de Sinèty makes the proportion one in four.

Reproduction is a much more complex and protracted process, and therefore much more liable to be disordered, in the female than in the male. The function of the latter ends with the discharge into the vagina of normal spermatozoids, while the former must not only have the *potentia coeundi*, but also the *potentia concipiendi*, and the *potentia gestandi*. The definition of sterility which has been given excludes *impotentia coeundi;* if coition be impossible, as from absence, atresia, or stenosis of the vagina, from vaginismus, or from other causes, the woman is said to be impotent, sterility being of course the necessary consequence of the impotence. The various conditions which cause impotence in the female, and their treatment, have already been considered, and therefore no further reference to them is necessary.

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[1] See New Orleans Medical Journal, 1844; American Journal of Obstetrics, vol. i.; Simpson (Medical Times and Gazette, 1859, 1860); Seeligmüller (Real-Encyklopädie der gesammten Heilkunde, Band iii.); Worms (Dictionnaire Encyclopédique des Sciences Médicales, première série, tome xviii.); Lamb (Centralblatt für Gynäkologie, 1882).

Conception is the union of normal spermatozoid and ovule. This union, it is believed from observations made in inferior animals, takes place at or near the ovary, at least in the external third of the oviduct. In studying the causes of sterility arising from *impotentia concipiendi*, it is necessary to consider first the obstacles which may prevent spermatozoids from reaching the ovules.

The seminal fluid after being discharged in the vagina may be expelled by vaginal contractions. Such non-retention has been observed in some of the inferior animals, and there is a popular notion that it is a cause of sterility in the human female, many women in fact attributing their childless condition to it; it has been observed, though not exclusively, in cases where the vagina is broad and short. It is usually attributed to genital erethism, but Duncan thinks it especially common in those sterile women who have not sexual pleasure. It is possible, as in an instance observed by Beigel, that the seminal secretion may be so thick and viscous that the movements of the spermatozoïds are hindered; in the case narrated by him, the injection of a little warm water after coitus ended the sterility. The vitality of the spermatozoids may be destroyed by the acidity of the vaginal mucus; a knowledge of this fact has led to the successful treatment of some cases of sterility by alkaline vaginal injections. The vaginal secretion may by its quantity, as well as by its quality, be injurious to the spermatozoids, especially if the discharge of seminal fluid be small. In cervical catarrh, the discharge, which is normally alkaline, may become acid, and destruction of the spermatozoids may result. In other instances the abundance of this secretion washes away the seminal fluid. Urine, especially if decidedly acid, is poisonous to spermatozoids; hence, in part, less liability to pregnancy in a woman suffering with vesico-vaginal fistula. Various theories have been propounded to explain the entrance of the spermatozoids into the uterus; some writers assert that the latter draws in the seminal fluid, but the best explanation is probably to be found in the inherent activity of the spermatozoids themselves, which thus enter *proprio motu;* it is possible, too, as claimed by some, that the uterine neck has a special excitability, more or less independent of voluptuous sensation, and that this facilitates the entrance of the semen.

The various positional disorders of the uterus are regarded as causes of sterility, but some of them act in preventing gestation rather than conception, and in general they are less important factors in the etiology of the sterile condition than the school of mechanical uterine pathology has held. Flexions are less liable in themselves to cause sterility than versions, since they do not change the relation of the vaginal cervix to the vagina; retroflexion does not hinder conception, but is frequently the cause of abortion. The liability to sterility in prolapsus of the uterus is in proportion to the degree in which the organ is displaced; nevertheless, even in complete prolapsus impregnation has occurred, coition taking place through the os uteri. Catarrhal disease of the cervical canal is a frequent cause of sterility, either by the quantity of secretion, or its character, or by the accompanying swelling of the *plicæ palmatæ* obstructing the canal. A conical cervix is, usually if not always, a cause of sterility; in such a case the external os is usually small, and the cervical canal may be occupied by a thick, tenacious mucus which furnishes a mechanical obstacle to the ascension of spermatozoids. Hypertrophy of the uterine neck may also cause a woman to be sterile; tears of the neck, when followed by sterility, are less often themselves the factors than are the disorders which they produce, or which are associated with them; such injuries may lead to abortion or to premature labor, and thus interfere oftener with gestation than with conception. Anteflexion with dysmenorrhœa is a frequent cause of congenital sterility. Impregnation has frequently occurred in cases of cancer of the cervix, and the pregnancy is not liable to be interrupted if the disease does not extend beyond the internal os. Failure in the development of the uterus is a cause of sterility. This is not a frequent cause, Beigel's statistics showing that in one hundred and fifty-five sterile women, there were only four with a *uterus infantilis;* Kisch[1] found sixteen in two hundred.

Admitting that spermatozoids may pass to the point where conception normally occurs, disturbances in ovulation and the migration of the ovule may prevent the union, or, this having occurred, the transmission of the ovum to the uterine cavity. The ovaries may be absent, or insufficiently developed, and in either case ovulation is necessarily absent. Ectopia of the ovaries may prevent the liberated ovules from entering the oviduct. Certain cachexias, as those arising from the prolonged use of alcohol or of opium, or from intermittent fever or tuberculosis, may prevent ovulation, or may lead to the formation of imperfect ovules. Fat women are liable to sterility, probably from an imperfect development of ovules. Women suffering from ovarian tumors are sterile, according to Veit, in the proportion of twenty per cent.; nearly one-half of those who have ovaritis are sterile.

While menstruation is usually associated with ovulation, and is therefore regarded as its indication, yet the latter may occur without the former, as is shown in the case of girls who have been impregnated before menstruating, or of nursing women who conceive though the menstrual flow has not reappeared since labor. Ahlfeld reports the case of a woman who bore eight children, and had never menstruated. Nevertheless, as a rule, a woman who has amenorrhœa is sterile. Displacements of the oviduct, catarrhal swelling of its lining membrane, and accumulation of the products of salpingitis in its canal, cause sterility by preventing the transmission of the ovule from the ovary, or of the ovum to the uterine cavity.

Instances have occurred in which a marriage has been sterile for years, and yet when each partner has sought a new alliance, reproduction has followed. A soil may be unsuitable for one kind of grain, and yet be quite productive when another is planted in it. L. de Sinéty suggests that in such cases of relative sterility the explanation is found in the physiological differences of the ovules or of the spermatozoids of the different subjects; thus in the case of the ovules, they may be difficult of penetration by spermatozoids, while the spermatozoid of one man may be much more active, may have more force, than that of another. A temporary or partial sterility follows the birth of male children, Pfankuch's statistics showing that with 240 married couples to whom 166 boys had been born, an interval of thirty and two-tenths months occurred before the next child was born, while after the birth of 134 girls this interval was only twenty-seven and four-tenths months.

Impotentia Gestandi, or Unfitness of the Uterus for Incubation.—The most frequent cause of acquired sterility, as far as the uterus is concerned, is uterine catarrh; the inflammation of the lining membrane of the uterus renders that membrane unfit for the attachment or nutrition of the ovum, or may give rise to hemorrhage which results in abortion. The development of the embryo depends so essentially upon the normal condition of the deciduous membranes, as recently clearly pointed out by Martin-Saint-Ange,[1] that it is easy to understand that catarrhal or syphilitic inflammation of the endometrium will often prevent or arrest gestation. Fibroid tumors cause sterility by the uterine catarrh or the hemorrhages which they produce; about one-half of women suffering from these growths are sterile, and those who bear children have only one-half the normal fecundity. Grünewaldt's statistics show the importance of inflammation of the various tissues of the uterus in the causation of sterility. Of 496 sterile women, 262 suffered from inflammatory processes of the endometrium, the mesometrium, or the parametrium.

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[1] See his elaborate article *Sterilität* in the Real-Encyklopädie der gesammten Heilkunde, Band xiii.

Certain uterine displacements interfere with the evolution of gestation, as retroversion or retroflexion of the uterus, especially if incarceration occur. Excessive sexual indulgence is a frequent cause of abortion, especially in the newly-married. Dr. Noeggerath[2] regards latent gonorrhœa as the most frequent cause of female sterility, and says that ninety per cent. of sterile women are married to husbands who have suffered from gonorrhœa either previous to, or during, their married life. According to Duncan,[3] the chief and best demonstrated sources of, or attendants on, sterility in women, are juvenility or prematurity, elderliness or post-maturity, dysmenorrhœa, and disorders of sexual appetite and pleasure. While some facts indicate that desire for and pleasure in coition may contribute to fecundation, there are other facts which prove these sensations to be unnecessary. Thus women have conceived although utterly indifferent to or disgusted with sexual intercourse, and even when having the greatest antipathy to their husbands; and others when anæsthetized, stupefied by alcohol or narcotics, or overwhelmed by fear and compelled to yield to brutal force; again, mechanical impregnation cannot be supposed to evoke any pleasurable sensation. It seldom happens, especially in acquired sterility, that the disorder depends upon a single cause; thus there may be uterine or pelvic inflammation associated with uterine displacement.

Treatment.—Of course where there is *impotentia coeundi* the problem as to treatment is usually simple. But in the larger number of sterile women no such difficulty is present to explain the failure to reproduce. Being quite sure that the wife is in fault, the first step is to ascertain the cause or causes, and then seek to remove them. If the uterus be undeveloped, the most important remedy will be found in electricity, and especially in the use of Simpson's galvanic stem pessary, or of some of its modifications; the instrument as usually found in the shops is too long to be safely worn in a pubescent uterus, and therefore a shorter one should be procured, adapted to the individual case.

Where the sterility arises from excessive coition, this should be restricted to once in ten days or two weeks, or it may be well to require entire abstinence for a few months. Vaginitis is, if present, to be appropriately treated. If the acidity of the vaginal secretion be marked, the use of an alkaline injection is advised, this not only neutralizing the acid, but increasing the activity of the spermatozoids. The best mixture, according to Kölliker, to give this greater activity, is composed of one part of potassa or soda, one hundred and fifty of sugar, and one thousand of water. Charrier used as a vaginal injection, for two women who had been four years sterile, a mixture containing the white of an egg, fifty-nine grammes of sodium phosphate, and a thousand grammes of water; in six weeks each patient had become pregnant.

[1] Iconographie Pathologique de l'Œuf Humain Fécondé. Paris, 1884.

[2] Transactions of American Gynæcological Society, vol. i.

[3] Sterility in Women, 1884.

The injection should be used a short time before coition, the pelvis being elevated so that the entire vagina may be thoroughly bathed with the solution.

While displacements of the uterus are not such important factors in causing sterility as inflammatory lesions, yet they should not be neglected, as their correction will at least facilitate the entrance of the spermatozoids into the uterus. In some cases of positional disorder of the uterus, coition in unusual positions has been followed by fecundation; thus, in anteversion the position of the partners may be reversed, or if there be a latero-version, they may lie upon the side toward which the os uteri is directed. If the os be plugged by tenacious mucus, Hisch advises the application of a glycerine-tampon for several hours before coition, and shortly before, an injection of a solution of sodium phosphate to which sugar or glycerine has been added, each of these facilitating the action of the spermatozoids. Where the sterility has resulted from a conical cervix, or from hypertrophic elongation of the cervix, favorable results have been obtained by amputation. Tears of the cervix are in some instances the cause of sterility, and the operation of Emmet is then plainly indicated.

Various local applications are advised for cervical catarrh, the most valuable of which, probably, is iodine in its nascent state, as first successfully used by Chéron in cases of sterility resulting from this disease. The formulæ recommended are, one gramme of the iodate and ten of the iodide of potassium, with fifty grammes of water; and ten of citric acid with fifty grammes of water; each solution is colorless. By means of a cotton-wrapped applicator, the first solution is applied freely to the cervical canal, and then, a fresh wrapping of cotton being used, the second solution is similarly employed, causing an immediate liberation of iodine. Of course such applications must be repeated at suitable intervals, and other appropriate treatment must be conjoined.

Stenosis of the cervical canal has been treated by incision and by dilatation; the latter method is gradually supplanting the former. The dilatation may be gradual or rapid. In the former case, sea-tangle or tupelo tents are introduced into the cervical canal, where they gradually expand, or else graduated bougies, made of hard rubber or of metal, are used, a larger one being introduced every second or third day, and the instrument being kept in place for five or ten minutes. Rapid or abrupt dilatation is usually effected by means of two-bladed steel dilators, of which Ellinger's is the type—Wilson's is an excellent instrument, and in this country Goodell's modification of Ellinger's is much used—complete expansion being accomplished at once, or in successive sittings; in the former case an anæsthetic should be given. The cases in which success has been most remarkable have been those in which the stenosis has been caused by anteflexion, and in which dysmenorrhœa has been a prominent symptom. Duncan believes that the benefit from dilatation is not in increasing the size of the cervical canal, but in overcoming the rigidity of the cervix. In all these operations it is important that antiseptics should be used.

Considering that in four-fifths of cases of acquired sterility there are the evidences of parametric and perimetric exudation, the importance of properly treating pelvic inflammations, whether of the connective tissue or of the peritoneum, is evident; so too of the removal of inflammatory deposits that may remain after the inflammation has ceased, and of the liberation of the uterus, where possible, from adhesions that may have fixed it in an abnormal position. If the sterility be dependent upon a diathesis, or upon a cachectic condition of the system, the treatment of such diathesis or condition is indicated. Nevertheless, in many such cases the cure of the sterility is not desirable; society does not need diseased and degenerated products, "destined to misery or crime," but healthy offspring. Where the sterility is associated with obesity, regulation of diet and suitable exercise, if the patient can be brought under proper control, may cause the condition to disappear.

Artificial Fecundation.—This should be regarded as the *ultima ratio* in the treatment of sterility; it is rarely proper, and success is doubtful and to be obtained only with great patience and perseverance. In its performance, an ordinary hypodermic syringe, to which a suitable rubber canula has been adapted, may be used. The canula is inserted into the uterus, and a small quantity of the fresh seminal discharge is placed in the syringe, which is then applied to the canula, and two or three drops are injected into the womb. The patient remains in a horizontal position for several hours. The time when success is least doubtful is a few days after menstruation; failing then, an attempt may be made a few days before the flow is due.

NYMPHOMANIA.

Nymphomania is an affection of the female corresponding to satyriasis in the male, and may be defined as an uncontrollable and insatiable desire for coition. Voisin[1] refers to it as the violent, disordered, and almost continual expression of the reproductive instinct. Synonyms are *uteromania*, *metromania*, *andromania*, *erotomania*, *hypathia*, *furor uterinus*, and *hysteria libidinosa*. Esquirol, and other writers have followed his example, restricts the term erotomania to a purely intellectual and moral affection—a platonic love —while nymphomania is essentially and solely sensual and fleshly, the madness of salacity, the delirium of lust. The disease has been observed in children only a few years old, and also in the octogenarian, but occurs most frequently, according to Foville,[2] at the beginning and at the end of sexual life.

Writers have been accustomed to describe three periods or stages in the disease. In the first, the patient is silent, depressed, and melancholy; she has voluptuous dreams and reveries, but her obscene thoughts and lustful desires are carefully concealed, and her will still governs her conduct. In the second period she no longer hides her desires, but, especially in the presence of the male, with lascivious looks and voluptuous attitudes testifies to the strong passion which rises superior to her will. In the third stage there is a complete abandonment of all propriety and decency, and entire loss of self-control; as Cabanis has said, the timid girl is transformed into a *bacchante*, and the most sensitive modesty into a furious audacity which not even the effrontery of prostitution can approach; Manget mentions the case of a young girl of noble family, and very modest, who in her attacks of nymphomania *homines et canes ipsos ad congressum provocabat.*

Etiology.—A predisposition to nymphomania may be present in some cases, especially as determined by heredity; in some females of vivid imagination the disease may be caused by impure associates, whose evil communications corrupt good manners, or by such pictures, novels, plays, and dances, as suggest licentious thoughts and excite the genesic instinct; the so-called revelations of the secrets of love to a young girl by an older companion, are too often the kindling of the flame of foul lust which utterly consumes modesty of manner and purity of character. "Nymphomania is observed, in the character of a secondary or transitory symptom, in different forms of mental alienation, such as the period of the beginning of general paralysis, the expansive phase of circular insanity, hysteric insanity, simple or epileptic mania, imbecility and idiocy in their periods of excitement."[1] Enforced continence after free indulgence in coition, as occurs to a widow, has been a cause of the disease in some cases; while in others it has been produced by venereal excess or self-abuse.[2] Certain diseases of the uterus and of its appendages sometimes produce an excitement which gives rise to nymphomania; but in such cases its intensity is rarely as marked as in affections of the nervous system, its duration is shorter, and it only exceptionally has the same consequences. Other causes are diseases of the vulva which produce intense itching, parasites of the vulva or of the rectum, the abuse of drastic purgatives, certain affections of the kidneys or bladder, etc. The question as to certain medicines or foods exciting venereal passion in the female, is still an open one. The ancients held that a diet of fish had this effect, because Venus was born of the sea, while in modern times cantharides has been used for the purpose. In regard to the effect of this drug, Gubler observes that its aphrodisiac action has not been shown except in persons of the male sex, and that there is not recorded an explicit and detailed case among females. Still, he believes that, though the fact is unproved, woman is not exempt from a certain degree of genesic excitement resulting from vesical and urethral cantharidism.

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[1] Maladies Mentales.

[2] Nouveau Dictionnaire de Médecine et de Chirurgie Pratiques.

Treatment.—The observation of Hippocrates led him to assert: *Ex utero furentes, si concipiant sanae fiant.* Fabre says that there are examples of nymphomaniacs who have been well during pregnancy, but in whom the disease has returned after their confinement. Marriage therefore, as he points out, ought not to be, though it has been, recommended as a therapeutic means; it would be an inefficacious remedy, and a frightful evil for the husband.

The importance of hygienic and moral treatment, in certain cases, is most important: intellectual diversion, pure thoughts suggested to cast out the unclean, plain and simple food, cheerful and constant occupation, daily bodily exercise even to slight fatigue, remaining in bed only long enough for necessary sleep, and a most careful avoidance of all that can excite sexual passion.[3] The exhibition of anaphrodisiacs may also be required; the potassic bromide is generally regarded as the most reliable of this class of remedies. Local disease, as of the sexual or adjacent organs, is to be met with appropriate treatment. Extirpation of the clitoris, or section of the nerves supplying it, has been successfully resorted to in some cases of nymphomania; but, rational as at first glance the practice may seem, it has often disappointed the expectations of the operator, and has only exceptionally been beneficial. Nymphomania is held by some writers to furnish an indication for extirpation of the ovaries, and the operation has accordingly been done under these circumstances; but in some cases no permanent benefit has resulted, and it remains to be proved that this mode of treatment is justifiable. Certainly its propriety is questionable if it be true, as claimed by many of the advocates of the operation for other diseases, that removal of the ovaries does not impair sexual enjoyment. Nor does it seem probable that the removal of any sexual organs which are in a normal condition, can cure a disease dependent probably in the majority of cases upon faulty mental or cerebral conditions, either hereditary or acquired.

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[1] Foville, op. cit.

[2] Bouchereau, Dictionnaire Encyclopédique des Sciences Médicales.

[3] In the female there are two chief seats of pleasure in sexual intercourse—the clitoris and the vagina. I have thought that by making sedative applications to these, possibly the excessive desire for coition manifested by the nymphomaniac might be lessened or subdued. Acting upon this hypothesis, I have recently prescribed, in a case of nymphomania, applications of a solution of muriate of cocaine.

THE CÆSAREAN SECTION AND ITS SUBSTITUTES; LAPAROTOMY FOR RUPTURED UTERUS AND FOR EXTRA-UTERINE FŒTATION.

BY

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OF PHILADELPHIA.

THE CÆSAREAN SECTION; GASTRO-HYSTEROTOMY OR LAPARO-HYSTEROTOMY.[1]

HISTORY.—Although the uniformity of meaning in European languages, viz., the "*Cœsar-cut*," would appear to indicate an ancient Latin origin of this operation, there is nothing reliable to prove that this method of delivery either gave a name to the Cæsar family, or received its own therefrom. As a *post-mortem* operation,[2] there is reason to believe that it antedates the Christian era; and that a Roman law made its performance compulsory, is highly probable, when we consider that when there is no penalty, as in our own day, children are permitted to perish in utero, in cases where the family decline to have the knife used for delivery. Examples of this are remembered to have occurred even in the higher walks of life in Philadelphia, and one instance was given by the late Prof. Nathaniel Chapman, where his offices were forbidden, although fœtal motion was decided and unusually long maintained. With regard to the claim that the Babylonian Talmud, which was compiled in the fifth century A. D., or possibly earlier, and other Jewish records, provide for a special purification for women who have been delivered by the abdomen, we have only to say that learned Hebrew scholars in and out of the medical profession have held contrary views upon the subject, and that the claim that the Cæsarean operation was known and designated in these books, appears to rest upon the value and meaning of a very few Hebrew words, which are capable of being interpreted either for or against it. The views of competent Jewish physicians have usually been adverse to the claim of the measure of antiquity mentioned, and such observers advance the opinion that there has been a misconception of the meaning of these ancient laws of the nation.

The early records of the operation are generally regarded as very unreliable, and grave doubts have been cast upon almost every case prior to that of Trautmann, of Wittenberg, who operated on April 21, 1610, and lost his patient suddenly, probably from cardiac thrombosis, on May 16, twenty-five days subsequently. I am not, however, willing to deny some of the prior claims, as there are reasons for believing that the operations were performed as stated. The celebrated Ambroise Paré (1509–1590), of Paris, wrote in 1561, and opposed the performance of the operation except in the interest of the fœtus, after the death of the mother, giving as his reason that the women operated on perished of hemorrhage. His pupil and successor, Jacques Guillemeau (1550–1612), stated that he had operated twice on living women, and that MM. Viart, Brunet, and Carbonnet had each done so once, all of the five cases proving fatal. On this ground he also opposed the operation until after death, and although he admitted that another operator had been more fortunate, still he held to his opinion, saying, laconically, that *one swallow did not make a summer.* Dr. Edward C. J. Von Siebold casts a doubt upon the character of the reported cases of the sixteenth century, believing them to have been laparotomies following rupture of the uterus, as the children were usually dead. But the danger attributed to hemorrhage, indicates to my mind that the uterus must have been opened by the knife. As the two operations have often been confounded, and both are frequently recorded as "*Cæsarean*" even at the present day, by writers who ought to know better, it is highly probable that a portion of the cases of that period were laparotomies simply, and not laparo-hysterotomies or gastro-hysterotomies.

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[1] Synonyms:—Kaiserschnitt (*German*); Kejsarsnitt (*Danish*); Kesarskoe siechenie (*Russian*); Hystérotomie (*French*); Histerotomia césarea (*Spanish*); Tagleo cesareo (*Italian*); Cieciu cesarskiem (*Polish*); Operaçao cesareana (*Portuguese*); Section cæsarea (*Dutch*). The term *gastro-hystérotomie* was introduced in 1816, by Prof. Gardien, of Paris.

[2] The first direction by a medical writer for the performance of the post-mortem operation, is that of Gui de Chauliac, in his work on surgery, written about the middle of the fourteenth century. He directs that the abdomen should be opened on the left side "*to avoid the liver.*"

We may go back still further to "about the year 1500," when, according to Caspar Bauhin, who wrote in 1588, Jakob Nufer, of Siegenhausen, Germany, a cattle gelder, and probably a cattle spayer also, operated with success upon Elizabeth Alespachen, his wife, after her case had been considered hopeless by the attending midwives. This woman is said to have given birth naturally to other children at later periods. There is nothing at all improbable in this statement, and but for the time that elapsed between the operation and its record we should not question its correctness. However, this may also be passed over, since I have myself with positive certainty traced back a Cæsarean case to an early part of the present century. I am also the more inclined to credit the Nufer operation, from the fact that Mary Donnally, an Irish midwife, is known to have operated upon Alice O'Neill with success, on January 9, 1738; and that a plantation midwife of Louisiana accomplished the same feat, near New Orleans, upon a young slave primipara, in 1838, the child in this case being saved as well as the mother; the midwife was intoxicated and very ignorant, being what is known as "*a plantation granny.*"

Several operations have been claimed for the fifteenth century, viz., one in 1400, a second in 1424—saving a lady and child at Créon, France—and a third in 1491.[1] These have all been credited by some writers and doubted by others. After the statement by Sir John Hayward, in his "Life and Reign of Edward VI., of England," that the said king was removed from his mother Jane Seymour, wife of Henry VIII., in October, 1537, by the Cæsarean section—a story without the least foundation—I must feel inclined to question many of the Cæsarean records.[2] The same must be said of the classic claim to the operation, which has no better foundation than a statement of Pliny the historian, who certainly made many assertions that are extremely fabulous, and that are adapted to bring others that may be better founded into discredit. As the ancient Greek and Latin medical writers make no mention of the operation whatever, I am not inclined to credit what is said by Pliny. But there is another and still better reason for believing that the operation may have all the age in the world that has been claimed for it.

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[1] Recorded in Venice, by Nicolas de Falconis.

[2] Klein has collected 82 cases, dating from 1500 to 1769.

As it has been several times performed with success in modern times by ignorant and excited women suffering the pangs of labor, it is reasonable to presume that the same may have happened at almost any period in the past. One of these self-inflicted and successful operations was performed by a negro slave near Kingston, Jamaica, in 1769.[1] A second, was the work of a quadroon of Nassau, New York,[2] in 1822, who was but fourteen years old, and pregnant with twins: she was alive and well when seen at the age of twenty by the physician who had dressed her wound. A third case is still more in keeping with what we believe may have happened in ancient times. In 1879, a woman at Prischtina, Austria, not far from the Servian border, was in the pains of labor for three days, but to no purpose. Having no prospect of relief, she seized a razor and cut open her abdomen and uterus: the child was removed alive; and she then got a neighbor to sew up her wound.[3] Several months afterwards, she and the child were reported as well. As there have been also, in modern times, several well-authenticated cases in which women have been delivered of children by the "*untimely rip*" of a cow's horn, most of these escaping a fatal issue, we may naturally infer that the same animal must have long ago proved the possibility of success in this mode of delivery, and led to a hope in the promise of relief by the knife.[4] We also learn through Robert W. Felkin, F.R.S.E., who witnessed an operation in 1879, that the natives of Uganda, in Central Africa, are in the habit of performing it. The woman he saw was a primipara of 20, who with her child was saved.[5]

INDICATIONS FOR THE OPERATION.—In noting the causes of difficulty which have led to the employment of the Cæsarean section within the present century, in different countries, we are struck with the fact, that what has been considered a proper reason for the use of the knife in one country, has been denounced in strong terms as insufficient in another. The greater mortality after the early operation in Great Britain, as compared with the United States, must of necessity limit its adoption to such cases as present the greatest possible obstacles to craniotomy and evisceration; and what might be considered, in the light of prospective success, a fair ground for abdominal delivery in the latter country, would not be in the former. Other reasons have been advanced upon the continent of Europe, which have led to the operation being performed, for the saving of the child, upon women having but a moderate pelvic deformity, or upon women in a dying condition; but these refer to questions of baptismal belief, and are not properly surgical. The fact must also be noted, that the operation presents a much more encouraging prognosis in country places and small towns in our own country, France, Austria, Germany, and Italy, than in large cities, and especially in the large maternities of Paris, Berlin, Vienna, and Milan. In the United States, there have been in all only eight hospital operations, but all were fatal.

The most common cause of dystocia leading to gastro-hysterotomy, is rachitic deformity of the pelvis, and next to it (in Europe), pelvic collapse from malacosteon. Other causes, are kyphoscoliosis; dwarfing of the pelvis; fibroid tumors blocking up the pelvis; exostoses from the ischium or sacrum;

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[1] Mosely on Tropical Diseases, p. 89. 1789.

[2] New York Med. and Phys. Journ., vol. ii. p. 40. 1823.

[3] Wiener med. Wochenschr., No. 13, 1880.

[4] Of seven cases on record, all but one ended in recovery; two children torn out at maturity were lost, as was one removed at six months; one removed at eight months lived eight hours; and three were ultimately saved.

[5] Edinburgh Med. Journ., April, 1884, pp. 922-930.

epithelioma of the cervix; obliteration of the os uteri; cancer of the vagina; atresia of the vagina; and impaction of the fœtus in a transverse position, generally with an arm protruding.[1] The measure of pelvic deformity requiring the operation, is differently given by obstetrical writers in different countries, it being reduced to a minimum in England, where the use of the knife is regarded as the last resort, and where the life of the fœtus is considered of little value when that of its mother is in peril. In our own country, past experience with the Cæsarean section leads us to believe that the operation is less dangerous than craniotomy in pelves having a conjugate diameter of two inches or less. Having saved 75 per cent. of the patients operated upon *in good season*, we are not inclined to regard craniotomy as the preferable expedient, where the conjugate measures $1\frac{1}{2}$ or $1\frac{3}{4}$ inches. And, besides, we hope for better results in the general average of cases, from antiseptic surgery and from the use of improved methods in suturing the uterus, whenever the whole medical profession in the United States shall have come to realize the importance of greater carefulness in the time and method of operating.

Risk in Operating.—In measuring this fairly, we must consider, 1st, the danger of the operation *per se*, and 2d, that which is superadded by the delay in operating, the prior attempts at delivery, and the physical condition of the patient before the commencement of her labor. If an operation is elective, the fœtus alive, and the patient in a favorable condition, previously well nourished, and of temperate habits, the past record of the United States leads us to rate the prospect of success as 3 to 1. In Great Britain, on the contrary, we must look for the reverse, as her past record of early cases shows that the probability of death is as 3 to 1. This is inferred from the fact that of 28 women operated upon in the United States in good season, 21 recovered, while of 33 in Great Britain, only 8 were saved; the children delivered alive numbered 23 and 26 respectively. Here then we come to a difference which can only be accounted for by the relative advantages of the patients and their surroundings in the two countries. The American patient is, as a rule, better fed and housed, and far less given to beer or gin drinking than the English, and has rarely (only once in 19 times) been operated upon in hospital. The English woman, being inferior in fitness for the operation, rarely recovers under the most skilful hands. In country and village practice, in parts of France, Belgium, and Germany, particularly where a number of operations have been performed by the same physician, the proportion saved has been unusually large. Thus, Dr. Découene of Courtrai, Belgium, operated (1841–51) six times, and saved 5 women and 4 children.[2] Dr. J. P. Hoebeke, a surgeon of Sotteghem, East Flanders, and afterwards of Brussels, reported (1829–39) eleven Cæsarean operations, saving 6 women and 9 children. Two of these cases were laparotomies after rupture of the uterus, one resulting fatally, which reduces the true Cæsarean operations to 9, with 5 women saved (one of whom had twins) and 9 children. The operator stated in March, 1839, before the Société Encyclographique des Sciences Médicales, of Brussels, that he had delivered 16 women by the Cæsarean section, saving 11. In 1840 he published a surgical and obstetrical paper of 87 pages, in which he claimed that he had performed "gastro-hysterotomy" 13 times, saving 10 women and 9 children.[3] Prof. J. A. Stoltz, of Strasbourg, in 1854, credited him with 11 cases, 6 cures, and 9 children saved. I am therefore inclined to credit him with only the 9 *true Cæsarean opera-*

[1] Of eleven cases of impaction, in the United States, seven were saved.

[2] Gazette des Hôpitaux, p. 221. Paris, 1852.

[3] Mémoires et Observations pratiques de Chirurgie et d'Obstétricie. Bruxelles, 1840.

tions. Prof. Stoltz, and Prof. Kilian, of Bonn, each saved 4 out of 7 women. Dr. Ludwig Winckel, of Gummersbach, near Cologne, and afterwards of Mülheim, operated 13 times, and saved 5 women and 10 children. He has been credited with 17 cases; but 4, with 3 saved, were certainly laparotomies after ruptured uterus, as shown by the record which he has sent me. He has probably operated in private practice more frequently than any other surgeon, not excepting Hoebeke, whose statements require explanation. The general mortality in the United States has been 60 per cent., and in Great Britain 81 per cent., including operations upon moribund subjects.

Causes of Fatality.—No one cause, and notably so in this country, is as potent a factor in determining a fatal issue in any case, as delay in operating. Long labor, or, in the cases of rachitic dwarfs, a few hours of labor, will exhaust a patient and favor the production of peritonitis, septicæmia, uterine inertia, and shock. If the uterus is sound, and its muscular power active by reason of not having been wasted by continued effort, it will contract at once when the fœtus is removed, the placenta will be squeezed off with but little bleeding, and there will be only a moderate risk of post-partum uterine relaxation or hemorrhage. Gaping of the uterine wound, with its accompanying risk of the escape of lochia into the abdominal cavity, is less common after early than after late operations, whence the greater importance of the uterine suture in operations of the latter class. When the fœtus is dead and putrid, even if the uterine wound be secured by multiple sutures against leakage, there is danger of septicæmia from the absorption of septic matters by the placental surface, or by the muscular portion of the uterine wound, which gapes toward the uterine cavity and exposes a raw surface to its noxious contents. This form of risk was demonstrated in a case which I saw lately, which terminated fatally in twenty-six hours from septic poisoning. The patient had been long in labor; the fœtus was dead and putrid; there had been a severe ante-partum hemorrhage; the tissues of the uterus had been changed by fibroid degeneration; and, although the peritoneal portion of the uterine wound was healed under the sutures, so that no fluid had escaped through it, there had been fatal absorption by the muscular portion of the wound, or by the sinuses of the placental site.

The most common cause of death after gastro-hysterotomy is peritonitis, and the next in frequency, septicæmia, the two being often confounded. Shock and exhaustion are not uncommon after a prolonged labor. Hemorrhage is very rarely a cause of death, and will be less so when the uterine wound is treated with multiple sutures. Phlegmasia dolens very rarely results from the operation, as does also intestinal obstruction from adhesions resulting from circumscribed peritonitis.

Modes of Operating.—I have no space to enter upon an account of the numerous past methods, with their varying lines of abdominal incision, and it will be sufficient to enumerate those which commence with a section through the *linea alba.* As country cases much more frequently recover than city ones, and private than hospital operations, it will not be as necessary in the former as in the latter to carry out fully the antiseptic system of treatment. To avoid delay is of much more consequence in the country than is the securing of a full corps of assistants, such as are required in operating antiseptically. An early use of the knife, in the country, has generally saved the patient, even when there have been no antiseptics or uterine sutures, and no anæsthetic or drainage employed, and when, if any, there has been but one medical assistant present. It is in cities, and especially in hospitals, that the improved precautionary methods, to be hereafter explained, are particularly needed. Here the mortality is largely in excess, and it becomes important not only to use antiseptics, but to suture the uterus and thus avoid the escape of noxious fluids into the abdominal cavity. We are not, however, to rest satisfied with the past results of country Cæsarean operations, but should also use all precautionary methods, and all improved measures calculated to diminish the mortality still further. Next to promptness in operating, I believe the most important steps to be suturing the uterus and cleansing the abdominal cavity from blood and amniotic fluid—measures the carrying out of which do not require any additional assistants.

Modern Antiseptic Operation.—The patient being warmly dressed, is to be etherized in bed, precautions having been previously taken to have her bowels and bladder emptied ; and is then to be removed to the operating table, which, if possible, should be in a room prepared for the purpose under carbolic spray, the temperature being from 75° to 80° Fahr. After placing her as for ovariotomy, the abdomen is cleansed with ether, and then with a five-per-cent. solution of carbolic acid. The vagina, also, is disinfected with a two-per-cent. solution, or with a $\frac{1}{2000}$th solution of corrosive sublimate. The operator takes his position to the right of the patient, with his chief assistant opposite him. Five assistants are required, viz., one to give ether ; one to attend to the sponges ; a third to hand instruments ; a fourth to manage the abdominal parietes, keep back the intestines, compress the abdomen against the uterus, and lift up the uterus with the index fingers inserted at the two ends of the uterine wound, as recommended by Dr. Ludwig Winckel, for the purpose of preventing the blood and amniotic fluid from entering the abdominal cavity, etc.; and a fifth to manage the spraying apparatus, provided that its use be thought advisable, about which there is much difference of opinion. "Listerine" may be substituted for the carbolic-acid spray, as much less disagreeable and safer to use. The incision is to be made in the linea alba, from the umbilicus to 1½ inches from the symphysis pubis, and may be carried above and to the left of the navel in cases of dwarfs. Pincettes are to be used to compress any bleeding vessels in the abdominal wall, and the uterus is then to be incised longitudinally with a scalpel, to the extent of about 5 inches, care being taken to avoid the fundus and cervix ; or the wound may be made partially, and extended by a probe-pointed bistoury. The first assistant now hooks up the uterus with his fingers. If the waters have not been emptied, the membranes are torn, and the patient turned on her side, or the waters are evacuated per vaginam. If the fœtal head presents at the wound, the operator should deliver it first ; but if not, should seize the feet, turn, and deliver. The fœtus should be carefully attended to if asphyxiated, until it breathes satisfactorily. The woman should receive a hypodermic injection of ergotine, and, when the placenta separates, the surgeon should remove it, cleanse out the clots, and mop out the uterine cavity with carbolized sponges. If there is hemorrhage, he should swab the uterus with vinegar, tincture of iodine, or alcohol, and, in extreme cases, with a solution of the perchloride or persulphate of iron. If the placenta is in the line of the incision, it will be necessary to peel it off on one side, and in some cases to tear through it in order to make a hurried delivery. Pincettes may be temporarily required to arrest the bleeding from the edges of the uterine wound, and vessels may also require ligation. Esmarch's elastic tubing may be used to constrict the cervix before opening the uterus, or the whole organ may be turned out and the cervix grasped by the hand of an assistant, and held until contraction has taken place. If the cervix uteri has not been dilated before the operation, a utero-vaginal drainage-tube should be inserted. The uterine wound is next to be closed with deep-seated and superficial, interrupted sutures of carbolized silk. The deep sutures should pass down nearly to the uterine lining, and the superficial ones should be inserted between them so as to turn in the peritoneum and bring its serous surfaces in apposition, to favor rapid union. From ten to twelve sutures of each form will be required, as the strain on each individual stitch will thus be less, and the welt will be made impassable to any uterine discharge. The next step is the cleansing of the abdominal cavity from blood and liquor amnii by means of carbolized sponges, after which the abdominal wound may be closed with silver-wire or silk sutures. The abdomen should then be carefully washed and dried, and dressed antiseptically, as after ovariotomy. The instruments used should all be placed prior to the operation in a two-per-cent. solution of carbolic acid; the sponges likewise, and the hands of the operator and his assistants should be washed therein, and should be re-cleansed when soiled.

UTERINE SUTURES.—In early operations, where the uterus is not diseased and where its muscular power has not been exhausted by expulsive efforts, closure of the uterine wound by stitches is not an absolute essential of safety, as many patients have recovered without it; but the experience of the past teaches us that it is safer to use sutures. Secondary inertia of the uterus may come on, and, without this safeguard, fluid may escape into the abdominal cavity; hemorrhage can be best checked by this form of hæmostasis, and a better union can thus be secured as a safeguard against rupture of the uterus in a future parturition. The first operator upon record who used sutures in the uterine wound was Dr. Le Bas, of Mouilleron, France, who did so on August 27, 1769, and saved his patient.[1] I find no record of a repetition of the measure until 1828, when an American charlatan was the operator.[2] The third to use them was Dr. Wiefel, of Hullesenbush, who used one suture only, and saved his patient. This operation was reported without date, in February, 1838, and must have taken place on August 22, 1837, or earlier.[3] The fourth suture case was operated upon by Dr. Godefroy, of Mayenne, France, on March 27, 1840, the patient being a rachitic dwarf, 42 years old, who had been two days in labor. He used three stitches of waxed silk, and the woman recovered.[4] Dr. Frank E. Polin, of Springfield, Kentucky, was the first to suture the uterus with silver wire, which he did in 1852; the patient recovered.[5] Two suture cases were saved in the United States in 1867, one with silver wire[6] and the other with thread;[7] both were late operations. The suture cases of this country now number 38, of which 7 were operated upon early, and 31 late. Of the early cases 3 recovered; and of the late ones only 9. The silver wire has saved 6 out of 12 cases. Catgut should never be used.

NEW METHODS OF PERFORMING GASTRO-HYSTEROTOMY.—These are all of German origin, and have been introduced within the last four years, in the hope of attaining a better success than has resulted in Germany from Porro's modification. They have been proposed, in order of time, by Drs. Cohnstein, Frank, Kehrer, and Sänger.

(1) *Cohnstein's Process.*[8]—The proposition of Dr. Cohnstein, of Heidelberg, is still in theory only. His plan is to open the abdomen by a long incision

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[1] Journ. de Méd., Chirurg., Pharmacie, etc., tome xxxiv. p. 177. 1770.

[2] Amer. Journ. Med. Sci., O. S., vol. xviii. p. 257. 1836.

[3] Casper's Wochenschrift, S. 123. 1838.

[4] Gaz. Méd. de Paris, No. 28. 1840.

[5] Medical Herald, vol. ii. p. 352. Louisville, 1880–81.

[6] New Orleans Med. and Surg. Journ., vol. xxi. p. 454. 1868.

[7] Med. Record, p. 1, 1868.

[8] Centralbl. für Gynäkol., Bd. v. No. 12, S. 290.

and turn out the whole uterus; then to incise it longitudinally through its posterior wall, remove the fœtus and secundines—care being taken to compress the aorta during the opening, evacuating, and contracting of the uterus—pass a drainage-tube through the Douglas *cul-de-sac*, and replace the uterus. The author of this method designed it from a belief that the greater thickness of the posterior wall would insure a better closure of the wound; that the weight of the uterus with the intestines upon it would aid in keeping the wound from gaping; and that the dependent position of the wound would insure proper drainage through the tube, in case there should be any escape of fluid from the uterine cavity into the utero-sacral fossa.

To this operation there are several decided objections. 1. In quite a number of Porro operations the plan of Müller has had to be abandoned, and the uterus has had to be opened *in situ.* There are cases in which it is either impracticable or unwise to turn out the organ as proposed. 2. There is a danger of encountering the placenta in making the incision, a complication which would occasion much greater difficulties than when the same is met with in front. 3. The high position of the uterus after parturition would cause the wound in its posterior face to discharge into the abdominal rather than into the pelvic cavity. 4. Recent cases of multiple suturing of the anterior uterine wound show that it may be rendered water-tight by the plan of welting-in the peritoneum, even in cases rendered almost hopeless by long labor, ante-partum hemorrhage, and exhaustion, as proved by autopsy after the operations of Drs. Garrigues, of New York, Jewett, of Brooklyn, and Drysdale, of Philadelphia, as well as by the recovery of several women in Germany.

(2) *Frank's Process.*[1]—The author of this method is the assistant of the celebrated Dr. Bardenheuer, of Cologne, well known for his nephrectomies and other surgical operations. The design is to make the operation in a measure extra-peritoneal, and to establish complete drainage. The plan is to open the uterus low down in front, and to make a pocket around the incision by bringing the two round ligaments together, so as to shut off the utero-vesical pouch from the general peritoneal cavity, suturing these ligaments in apposition by means of Czerny's suture silk, and establishing drainage from this closed pouch per vaginam.

Dr. Frank commences his operation by washing the abdomen first with ether and then with a five-per-cent. solution of carbolic acid; he also irrigates the vagina with the latter. He then opens the abdomen by a long incision, and turns out the uterus entire before incising it longitudinally in front, commencing low down in the vesico-uterine excavation. After evacuating the uterus, he washes its front and interior with the carbolized water, and again washes out the vagina with it. A large drainage-tube is passed through the uterine wound and out of the vagina, and the uterine wound is sutured above it with strong catgut; the tube also passes out at the lower end of the abdominal wound, which is to be sutured closely down to it. The pocket formed as already mentioned, is drained by a small tube passed through an opening into the vagina, just in front of the cervix, and a third tube is made to lie upon the uterine wound and extend nearly to the top of the pavilion. The drainage-tubes being placed, the round ligaments are then sutured together, and the abdominal wound is closed and dressed antiseptically.

If the size of the fœtus makes it necessary to extend the uterine incision further upward than usual, or if the round ligaments cannot be approximated through enough of their length without too much tension, exudation of lymph must be trusted to a certain extent to complete the vault of the pocket. As a distended bladder will obliterate it, the organ must be kept empty by a catheter constantly worn.

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[1] Beitrag zur Lehre von der Sectio Cæsarea. Centralbl. für Gynäk., 10 Dec. 1881, Bd. 5, No. 25, S. 598.

Dr. Frank has tested his method by delivering a woman who was hopelessly burned at full term, and who evidently had but a few hours to live; the child was alive, but growing weaker, and its extraction *per vias naturales* was found impracticable; it had a pulse of 150. The child was saved, and the mother died in ten hours. At the autopsy no blood was found in the general peritoneal cavity.

Many objections to this complicated operation will readily suggest themselves, not the least being that the inclosed peritoneal pocket is peritoneum still, and liable to peritonitis which may extend; and that, like the vagina, it offers a surface for the ready absorption of septic matters. Drainage-tubes are also not entirely innocent, and Porro operations have done better on the whole without them. The catgut uterine suture is also quite objectionable, as its knots will not hold when kept moist.

(3) *Kehrer's Process.*[1]—This method is not altogether new, as I will show presently: it is, however, in the main, original with Dr. F. A. Kehrer, of Heidelberg. It is claimed as an advantage of this operation, that the uterine muscle is incised at the spot where it is least inclined to cause the wound to gape by its contractions. After opening the abdomen in the usual way, the uterus is incised transversely in the anterior circumference of the internal os uteri, which, on an average, is a centimetre above the bottom of the vesico-uterine pouch.[2] The tendency to gape is here very little, and it is further opposed in a powerful manner by the normal position of anteversion after delivery during the child-bed period. In favor of this position for the incision, the author urges, further, that in this situation the placenta is rarely met with, whilst the head usually lies there, and thus early breathing of the fœtus is facilitated. He recommends the adoption of a double suture: one deep seated, to unite the muscular wall, and one superficial, to secure coaptation of the peritoneal portion of the wound.

The strictest antiseptic arrangements are to be employed before and during the operation; the interior of the uterus is to be thoroughly irrigated by a carbolic solution and wiped out with a carbolized sponge; the peritoneal cavity is also to be thoroughly cleansed. Dr. Kehrer is opposed to the use of the abdomino-uterine drainage-tube, and recommends two small tubes to lie on either side of the vesico-uterine pouch, and a third, larger and longer, to pass over the uterus and into the Douglas pouch.

Two operations have been performed after this method, both upon women diseased with malacosteon, and aged respectively 26 and 30, the first on September 15, and the second on November 13, 1881. The former recovered in thirty-five days, but the latter died in twenty-eight and a half hours. At the autopsy of the second, the margins of the uterine wound were found adherent, except at one point, where a triangular space was left uncovered by the peritoneum; over half a pint of sero-sanguinolent fluid was found in the abdominal cavity.

This form of incision is described in Robert Wallace Johnson's "New System of Midwifery," 2d edition, 1786, page 308, in these words: "I would have the incision made through the uterus transversely, on its anterior side, as near the cervix as not to injure the bladder, avoiding as much as possible the division of the larger branches of the hypogastric arteries; and this aperture being made of sufficient largeness, then to pass the end of a male catheter through a puncture made in the membranes, to draw off the liquor amnii, etc., so that an effusion thereof may not gush into the general cavity of the abdomen." These views of the author were based upon the fact that a patient of Dr. Andrew Douglas, who had ruptured her uterus transversely above its connection with the vagina on September 12, 1784, had made a good recovery, the rent being observed to have much diminished after delivery.

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[1] Archiv für Gynäkol., Bd. xix. Heft 2, S. 180. 1882.

[2] In Wiefel's operation, referred to under "Uterine Sutures," the uterus was incised transversely.

Dr. Johnson was also the originator of pelvic drainage, at least in theory, for at the time there was no way to carry it out. In the first edition of his work (1769), page 305, he writes, concerning the Cæsarean operation: "Could an aperture be made with safety at the bottom of the pelvis when hysterotomy is performed, in order to give vent to those humors, the probability of the mother's recovery would then I think be greater; but how such an opening can be effected, I will not take upon me to determine; nay, indeed, I must confess that I think it hardly possible."

(4) *Sanger's Process.*[1]—The originator of this method presented his ideas, with illustrations, in December, 1881, in a 200-page monograph which appeared in Leipsic in 1882;[1] since which date the modification has been several times tested successfully. The plan of operation is as follows: The abdomen is incised as usual and two strong ligatures are passed through the margins of the wound near its upper commissure, to be drawn upon as a bridle after turning out the uterus; the membranes are then ruptured through the vagina, and, if practicable, the uterus is lifted out and held vertically. A sheet of caoutchouc, moistened with a 5-per-cent. solution of carbolic acid, is next made to inclose the cervix and cover the abdomen, to protect its cavity against the entrance of fluid. The ligatures are now drawn upon to close the abdominal opening around the cervix, while the uterus is incised longitudinally in front and the fœtus is removed. If the uterus is not turned out, manual compression is to be made as a hæmostatic upon its lower segment. If opened after being turned out, manual compression is likewise used, or clamps are applied to the broad ligaments, or an elastic tube to the cervico-uterine cone, after the plan of Esmarch. After evacuating the uterus, any hemorrhage from the wound is to be checked with hæmostatic pincettes. When the uterus is well contracted, a utero-vaginal drainage-tube is passed, and a carbolized sponge is introduced into the uterine cavity. Next, the peritoneum is dissected free from the muscular layer around the uterine wound, and from the latter, on either side, is pared a long slice of tissue of a wedge-shape, having the thick edge next to the peritoneum, and the thin edge next to the uterine cavity. The free edges of the peritoneum are now turned in over the muscular layer, and deep-seated stitches of silver-wire or silk are inserted, so as to penetrate the peritoneal and muscular coats while avoiding the mucous coat. Then superficial stitches are inserted at short intervals, so as to secure the turned-in peritoneum and keep its serous surfaces in contact, making a secure welt. The abdominal wound is closed and dressed as after an ovariotomy.

Dr. G. Leopold, of Dresden, has performed this operation five times, saving four women and all of the children. His first operation was upon a rachitic woman, 29 years of age, and commenced as soon as the bag of waters had well descended. The operation required an hour in its performance, and the woman recovered in three weeks. She was operated upon at Leipsic, on May 25, 1882.[2] The child was living in 1884.

Another patient was operated upon by Dr. O. Beumer, of Greifswald, and died in forty hours. The woman was a sextipara 41 years of age, whose pelvis was blocked by a fibro-myoma which grew from the posterior wall of the cervix, and whose puerperal condition was also complicated by the existence of cystitis and suppurative pyelo-nephritis. She had been in labor some eight or ten hours prior to the operation, and before its conclusion showed symptoms of collapse. An autopsy revealed hypostatic pneumonia of the middle and lower lobes of the right lung; œdema of both lungs; excessive pyelo-nephritis, with destruction of a great part of both kidneys; incipient peritonitis; and an intra-mural fibroma, as large as a fœtal head, growing from the posterior cervical parietes and fixed in the Douglas space by old adhesions. The operation was performed on September 11, 1882;[1] the child was living.

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[1] Archiv für Gynäkol., Bd. xix. Heft 3, S. 397. 1882.

[2] Ibid., S. 400–450.

It is not at all necessary to pare away portions of the uterine wall in order to turn in the peritoneum, as the reduced size of the uterus renders this layer sufficiently loose to be drawn over the edge of the wound by a proper stitch, such as that of Gély would be, if taken transversely on either side and then tied across. Dr. Leopold said before the International Medical Congress at Copenhagen, that he would in the future avoid the removal of muscular tissue as not essential to success.[2] In three fatal cases in this country—fatal because of the condition of the women before the operation—in which multiple sutures, deep-seated and superficial, were used, and in which the peritoneum was drawn over the muscular edges of the uterine wound, the peritoneum was found to have fully united, and in one of them within twenty-six hours after the operation, as the result of a local peritonitis along the line of sutures.

The Cæsarean operation has *per se* a certain measure of fatality, which varies very much in different countries, and in different localities in the same country. It has a moderate fatality in the United States, except in hospitals and large cities; a very high one in Norway, Sweden, Denmark, and Great Britain; and it has been almost universally fatal in the large maternities of Paris, Milan, Naples, and Vienna. It has had again a moderate fatality in parts of Belgium, France, and Germany, among the peasantry. In the United States, where death or recovery largely depends upon the early management of a case, there is a vast addition to the fatal results through ignorance and senseless delay. The large proportion of deaths in the children shows a want of proper management of the cases prior to the operation. Recently, in a case where the true conjugate diameter measured but one and a half inches, one leg of the fœtus had been brought down and wedged into the superior strait.[3] Ignorance on the part of accoucheurs and midwives is shown all through our record, and particularly on the part of the former, who have done much to increase the difficulties of the cases. In another instance, a young accoucheur mistook the promontory of the sacrum for the fœtal head, and in attempting to perforate it transfixed the rectum in three places; the Cæsarean operation proving fatal in six days, an autopsy revealed this prior fatal injury.[1] In a third case, a fibroid tumor was thought to be a fœtal head, and the pregnancy to be an extra-uterine one, whence long and fatal delay in calling in an operator to afford relief. Such cases and numerous others are counted as fatal results of the Cæsarean section. Again, about one in five of the operations have been performed upon rachitic dwarfs, the worst of all subjects to recover after delay, as they rapidly become exhausted, do not rally after the operation, cannot bear much loss of blood, and have very little stamina at best. Such cases should be operated upon as soon as possible, as it is fatal to waste time in attempting craniotomy or version, and as delay itself is fatal even when nothing is done. What is most wanted for greater success in the operation is better knowledge on the part of the accoucheurs who attend the poorest classes in our large cities, among which the pelvic deformities which make Cæsarean section obligatory are usually found. When called in they ought at once to determine the state of the pelvis, and, if not ample, to send for an experienced consultant without delay. The fact that but seven dwarfs out of twenty-six have been saved in this country,[2] and that three-fourths of these were operated upon late, shows the importance of better knowledge and more prompt action upon the part of those first called in to such patients when in labor. It will be of little avail to introduce improved systems of operating, unless there is also an improvement in selecting a proper time for the operation; if this be made elective and not the last resort, there will be a diminished fatality in the future.

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[1] Loc. cit., Bd. xx. Heft 3, S. 409–424.

[2] Since the above statement was made, Dr. Leopold has twice operated without resection of the muscular coat of the uterus. The first of these operations (his fourth) was performed on Nov. 28, 1884, upon a rachitic secundipara, after 22 hours' labor, when feverish and having a pulse of 120. The serous membrane was separated and turned in, and the wound closed with deep silver and deep and superficial silk sutures. The woman died on the fifth day of septic peritonitis. His fifth operation was performed on Dec. 5, 1884, the patient being a primipara of 23, in labor 16 hours, and in a favorable condition; she had likewise a deformed pelvis. The uterine wound was managed without resecting the muscular coat, or peeling-up the serous one, the latter being simply drawn and turned in, as in the Garrigues and other American cases. There were used 6 deep-seated silver and 6 deep-seated silk sutures, with 10 superficial ones of silk. Both woman and child were saved.

Sänger's method, with resection, has been performed six times in Germany, and without resection twice, saving 6 women and 8 children. It has been performed once in Vienna by Dr. Ehrendorfer, upon an unfavorable case after a labor of two days. The woman died on the sixth day of "sanio-purulent peritonitis;" the child was saved. (Neue Beitrage zur Kaiserschnittsfrage, von Dr. M. Sänger. Leipzig, 1885.)

[3] Med. News, p. 256. 1885.

The Porro-Cæsarean Section—Laparo-hystero-oöphorectomy.

"*Utero-ovarian amputation as completive of the Cæsarean operation*," was the title originally given by Prof. Edoardo Porro, late of the University of Pavia and now of the Obstetrical School of Milan, to the modification of the old Cæsarean section which has been designed by him for lessening its mortality, by converting the internal uterine wound, with its tendency to gape and discharge septic matters into the abdominal cavity, into one dressed and discharging without the peritoneal cavity.

History.—This operation, in its main feature, existed as a theoretical improvement for one hundred and eight years before it was finally tested upon the human female. During this long period of probation, several experimenters, who nearly all appear to have acted independently of each other, came to the same conclusion, after testing their theory upon the lower animals, which was, that this might prove less dangerous to the parturient woman than the old method. To Dr. Joseph Cavallini, Surgeon-in-Chief of the Santa Maria Nuova Hospital of Florence, who published an account of his experiments in 1768, is due the credit of having first thought of the method which now bears the name of Porro, with the exception that his idea contemplated a complete hysterectomy, instead of an amputation of the cervix. He was led by the celebrated Antonio Cocchi to try a series of experiments upon dogs and sheep, to determine the danger of extirpating the uterus, with a view of employing it as a means of curing cancer of that organ. His monograph, published in Florence in 1768, was entitled "*Tentamina medico-chirurgica de felici in quibusdam animantibus uteri extractione*." Having successfully removed, from a bitch, the uterus, which contained nine pups, he wrote as follows: "I do not doubt that the uterus is not at all necessary to life; but whether it may be plucked out with impunity from the human body we cannot be certain, without a further series of experiments of this kind, *which perhaps a more fortunate generation may obtain.*" It is a singular coincidence, that the name of the first woman operated upon should also have been Cavallini.

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[1] Med. and Surg. Reporter, p. 375. 1869.

[2] Med. News, p. 258. 1885.

Dr. G. P. Michaelis, of Marburg, wrote in 1809: "It is indeed a question, whether the Cæsarean section would not be made less dangerous if with it were combined the extirpation of the uterus."

Dr. James Blundell, of London, who, in many of his views, was much in advance of the time in which he lived, was led by a series of experiments into the same train of thought. After saving three rabbits out of four, under hysterectomy, he wrote in 1828 as follows: "In speculative moments I have sometimes felt inclined to persuade myself that the dangers of the Cæsarean operation might be considerably diminished by the total removal of the uterus." . . . "Perhaps the method of operating may hereafter prove an eminent and valuable improvement."

Dr. Giacinto Fogliata, of the Veterinary Section of the Royal University of Pisa, made in 1874 a series of experiments, and saved three non-gravid bitches out of four, after the removal of their uteruses. In a monograph which he published in 1875,[1] he mentions the fact, that, in 1862, Dr. Jéser had operated in a similar manner upon the same number in a gravid condition, and saved two. Prof. Porro, without knowing of Fogliata's experiments, in the same year, 1874, removed the gravid uteruses of three rabbits, all of which recovered. In July, 1871, he had operated, in Milan, upon a young rachitic primipara, by the old Cæsarean section, after a labor of twelve hours; the child was saved, but the mother died in fifty hours from internal hemorrhage and metro-peritonitis. As this operation had been universally fatal in the hospital in Pavia, and almost so in the Maternity of Milan, he determined to modify it in the hope of diminishing its fatality.

Although the first *premeditated*, elective, Cæsarean utero-ovarian amputation was performed by Prof. Porro, he was not the first to remove a puerperal uterus by amputation of the cervix, this having been done of *necessity* in 1869 by Prof. Horatio R. Storer, of Boston (now of Newport, R. I.), who operated in a desperate case of hemorrhage, produced by the uterine wound of a gastro-hysterotomy which had been rendered necessary by the presence of a fibro-cystic tumor. The child was dead and putrid, and the woman had been three days in labor: she died of septicæmia in sixty-eight hours. Drs. Cavallini, Michaelis, Blundell, Jéser, and Fogliata all recommended a trial of *entire* extirpation of the uterus as a means of lessening the mortality after the Cæsarean operation; but Prof. Porro made the important changes of amputating the cervix and dressing it externally.

MODE OF OPERATING.—According to the directions of Prof. Porro, the first steps in his method are precisely those given under the head of *modern antiseptic Cæsarean section*, up to the point of suturing the uterine wound. His first operation was performed on May 21, 1876, upon a rachitic primipara of 25, who had been in hospital twenty-four days, and in labor less than seven hours. She had been under a tonic regimen, and in a private room, and was in a favorable state for the operation. Her height was 4 feet $10\frac{1}{2}$ inches, and the conjugate diameter of her pelvis $1\frac{9}{16}$ inches. She was operated upon under chloroform, and all of the participants washed their hands in dilute carbolic acid. After the uterus had been opened and its contents removed, it was brought out of the abdomen and held vertically; a wire loop of the constrictor of Cintrat was placed around it at a point opposite the internal os uteri, and then tightened by the screw until all circulation in the bloodvessels was arrested. The uterus was then cut away, two centimetres above the wire-loop; the abdominal cavity was cleansed with carbolized sponges, and a 5-millimetre drainage-tube was passed through the abdominal wound and the Douglas pouch, and out by the vagina. The abdomen was sutured with silver wire; the stump was touched with perchloride of iron, and fixed in the lower angle of the wound. The parts were then dressed with simple applications. The constrictor was removed on the fifth day, and the woman was well in forty days; her child was also saved.

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[1] Giornale de Anatomia, Fisiologia, e Patologia. Pisa, 1875.

Numerous changes have been made by different operators, some simple and valuable, others vital, and a few for the worse. Some of the more simple have been the securing of the stump by transfixing pins; the use of Koeberle's or of Maisonneuve's constrictor; of Spencer Wells's clamp; of Billroth's or Chassaignac's écraseur; and of spray and Listerian treatment. To check the loss of blood in the operation, the cervix has been surrounded with elastic tubing after the mode of Esmarch, or it has been compressed simply by the hand. To avoid the placenta, the uterus has been incised transversely above the internal os, and then torn across until the fœtal head could pass. The more vital changes have been made by Müller, of Bern, in Switzerland, and by Veit, of Bonn, in Germany.

Müller's Modification.—This method was introduced by Prof. Müller, on Feb. 4, 1878, as an improvement upon the eight Porro operations which had preceded his own. He operated upon a malacosteon multipara of 37, who had been 3½ days in labor, with a pulse of 136, and whose fœtus was dead and putrid. Notwithstanding her unfavorable condition, her abdomen was opened by a long incision, and the entire uterus turned out before it was incised. The abdomen being protected against the admission of fluid, the uterus was first constricted, and then opened and evacuated, after which the steps of the operation were the same as in the original plan. The object of removing the uterus from the abdominal cavity before evacuating it, was to avoid the danger of hemorrhage, and the possibility of its putrid contents escaping into this cavity among the intestines. The effect of removing these septic matters was shown by a fall of the pulse to 96 after the operation, and the next day to 84, while the temperature also fell from 102° to 97° Fahr. As this patient ultimately recovered after having had on the eleventh and twelfth days a pulse of 140 and 150 respectively, and in spite of the appearance of some gangrenous spots about the abdominal wound, the plan of opening the uterus without the abdomen was adopted by others as an improvement over the original plan of Porro; and the next to act upon it was Prof. Chiara, of the Santa Caterina Hospital of Milan. His was a case of induced labor in a rachitic dwarf, 4 feet 3½ inches high and 23 years old, and the operation was performed after labor had advanced 12 hours. The child was saved, but the woman died of diffuse septic peritonitis on the fourth day. This operation was the thirteenth in order of time—the second by Prof. Chiara—and took place on May 22, 1878. The result of this trial caused the staff of the hospital to adhere to the original method, and their success since has been very remarkable, as the 12 following operations have saved 11 women and 12 children. Better results have followed the Müller method in other hands, and it now ranks high, especially in cases where the placenta is attached to the anterior wall of the uterus, or where the fœtus is putrid after a long labor. As the cervix is constricted before the fœtus is delivered, haste is requisite in the extraction, as the fœtus will be in a state of asphyxia from arrested supply of oxygenated maternal blood, and may be lost, as happened once in Vienna. There are many cases in which the Müller method cannot be carried out, and there are no less than six embraced in Dr. Clement Godson's tabular records, in which the uterus could not be turned out after the long incision had been made, and in which the operators were obliged to evacuate it *in situ;* four of the women recovered. As far as ascertained, up to March 20, 1885, there have been 42 operations by the Müller method, saving 21 women and 31 children, and by the Porro operation, unmodified, 109, saving 46 women and 85 children.

Veit's Modification.—This experiment originated with Prof. Gustav Veit, of Bonn, Germany, and the initial operation was performed by him on March 21, 1880. The change consists in ligating and dropping in the stump, treating it as the pedicle in ovariotomy, or as the amputated cervix in hysterectomy, in non-gravid cases. Three other operators, the first in New York City, followed Prof. Veit, at intervals of 18, 25, and 33 days, and all four of the women were lost. The sixth case (the second of Veit); the twelfth, under care of Dr. Kabierski, Jr., of Breslau; the thirteenth, under care of Prof. August Martin, of Berlin; and the fourteenth, under care of Prof. Fritsch, of Breslau, ended in recovery. Six of the fourteen were originally Müller modifications, and three of the four saved were of this type. A mortality of 71$\frac{3}{7}$ per cent. is not adapted to recommend this manner of completing the operation, although in theory it has much to make its success desirable, as it would entirely obviate the very objectionable traction made upon the abdominal cicatrix, and secure an earlier union of the wound. The patient of Prof. Fritsch, operated upon in November, 1884, was well enough to leave the hospital on the fifteenth day. In the operations in which the stump has been dropped in, it has been treated in a variety of ways to secure it against hemorrhage, and to prevent its giving rise to septic poisoning. It has been ligated with silk in several forms, and with silver wire; it has been stitched with a cobbler's suture; and the peritoneum has been closely sewed over the end of the stump. The causes of death show the seat of danger to lie generally in the abdominal cavity. Of the 10 fatal cases, death was attributed to peritonitis in 3; to septic peritonitis in 2; to septicæmia in 1; to cardiac embolism following phlegmasia dolens in 1; to hemorrhage and carbolic acid poisoning in 1; to "anæmia" in 1,[1] and to shock and exhaustion in 1.

As this vital change in the operations of Porro and Müller has largely increased their proportionate mortality, I shall take the liberty of excluding the 14 operations in calculating the risk of the Porro-Cæsarean section, and also the 3 additional cases in which the women who were moribund were opened to save the fœtus. The exclusion of these 17 cases will reduce the Porro and Porro-Müller list of cases operated upon, *after the fœtus had reached a viable age*, to 148. Of this number, 65, or a fraction below 44 per cent., ended in recovery. Of the 148, 90 were favorable for the operation and 58 unfavorable. Of the 90, 53 were saved, and of the 58, only 13. Nine Austrian operators saved 20 out of 34 women, or a fraction below 59 per cent.; and five Italian operators, in the Maternity of Milan, saved 11 women out of 14 (or 86$\frac{3}{7}$ per cent.), and all of the children. Five Austrian operators saved, in the Krankenhaus of Vienna, 13 out of 26 women, and 23 children.

Other Minor Changes.—Prof. Litzmann, of Kiel, Germany, after turning out the uterus intact, in an operation performed on June 14, 1878, surrounded the cervix with the *elastic tubing* used in Esmarch's bloodless amputations before evacuating the organ. There was no loss of blood other than what escaped by the contraction of the uterus; the child was asphyxiated, but soon revived, and the cervix was dressed externally. The cervix being occluded, and its cavity containing pus, as was discovered on autopsy, the woman died of septic peritonitis on the sixth day. *Manual compression* as a substitute for the Esmarch apparatus was first employed by Dr. Leon Oppenheimer, of Wurzburg, Germany, on July 4, 1880. After emptying the uterus, he secured the cervix in the clamp of Sir T. Spencer Wells; the mother and child were saved. This plan of using manual compression after turning out the uterus, antedates the trial of the same process by Drs. Broomall and A. H. Smith, of Philadelphia, by nearly three years.

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[1] Said to have been secondary hemorrhage.

Like the old Cæsarean operation, it is very essential to success that the Porro modification should be performed early in labor, whilst the patient is in good condition and not prostrated by suffering; or, if thought proper, before labor has commenced. As there is very little discharge from the cervix, it is not essential that it shall be more than pervious. The greatest success in hospital is where the women have been put under preparative treatment, to improve their general condition of health and fit them for the operation. The Müller method is of advantage where there is a putrid fœtus in utero, and where there is danger from hemorrhage because of the placenta being located under the line of incision of the uterus. Dr. Godson, to escape cutting down upon the placenta in his operation, opened the uterus low down in front and tore it transversely with his fingers, making the opening according to the locality of Kehrer's incision described on page 0*e*9.

EFFECT OF THE PORRO MUTILATION UPON THE SUBJECTS OF MALACOSTEON.—Fortunately for the women of America, this is not one of their deforming diseases, and few of the obstetricians of our largest cities have seen a case even in a foreigner; but in some special localities of Europe, particularly in Belgium and Germany, it is a serious and fatal malady, not confined to women who have become mothers, but usually affecting only such, and particularly multiparæ. To cure this disease, even in its milder forms, has long been the desire of the accoucheur; but all remedies failed until the operation of Dr. Porro opened the way for a more effective system of management. Having learned indirectly that the operation of Prof. Josef Späth, of Vienna, performed on June 22, 1877, had cured his patient of her malacosteon, I opened a correspondence in the summer of 1884 with the operators of all the Porro-Cæsarean sections that had resulted favorably in the cases of malacosteon subjects, and the answers to my letters make it highly probable that some cases at least of the disease may be cured by the operation of Battey, as modified by Lawson Tait. Dr. Fehling's experience with three cases has at least decided him to perform this operation as a curative measure "in a case without pregnancy, when the bone softening does not disappear after the delivery." He writes of his three Porro cases, that the curative effect of the operation was quite perfect; that the disease in the patients operated upon in May, 1881, and March, 1882, "was very severe," notwithstanding which, both were re-established in health; and that the third, who was not so much diseased, but still had great difficulty in walking, was enabled to "walk perfectly well." These patients were not allowed to nurse, as Dr. Fehling regards the arrest of the mammary drain as essential to entire success. One child died of pneumonia when about six months old, and the first and third, the former over three years old, were in good health at the time he wrote. Dr. Fochier, of Lyons, operated upon his patient on February 2, 1879 she was a primipara of 33; and had since her recovery become able to take care of the rooms in a student's lodging house; he believed that the disease had been arrested by the operation. Dr. Chiara's case of October, 1878, in a sextipara of 43, was not so fortunate, as she lost two inches in height after the operation, and has still, in 1885, some evidences of the disease remaining. Other cases of cure might be mentioned, even in subjects long confined to bed, but those given make it probable that in its earlier stages the disease may be arrested in the manner proposed by Dr. Fehling. Of 24 strictly Porro or Porro-Müller cases operated upon because of malacosteon deformity of the pelvis, 15 recovered; the prognosis of the operation in this disease is therefore not necessarily unfavorable.

The Porro operation has entirely superseded the old method in most of the lying-in hospitals of Europe, and has reversed their tables of mortality completely. Where for many years every patient died, now at least 50 per cent., and in some hospitals a larger proportion, recover. It is true that antiseptic measures, preparative treatment, and early operating, have had much to do in effecting this, but there is also a very decided diminution of the death-rate due to the operation itself. It has failed in Great Britain in 9 cases out of 10, but this is due to the subject more than to the operation; in premature cases, at 2, 4, and 6 months, three cures have in England resulted from four operations.

GASTRO-ELYTROTOMY OR LAPARO-ELYTROTOMY.

Like the Porro operation, that which was brought to practical perfection in New York and Brooklyn in 1870 and 1874, under the above titles, was one which in idea, based upon a knowledge of human anatomy, had presented itself independently and in somewhat different types to the minds of several surgeons and obstetricians during a period of sixty-five years. The operation as it is now performed, originated with Prof. T. Gaillard Thomas, of New York, in 1870, who, without any knowledge of the ideas and attempts of his predecessors, first made trial of it upon the dead subject, and then, in March, 1870, upon a living woman, who, although in a dying state from pneumonia, was safely delivered of a living fœtus and survived the operation an hour. This patient was a multipara of 40 years of age, and pregnant seven months, and as the operation was performed in the interest of the fœtus, it is unfortunate that this proved to be hare-lipped and badly developed, so that it lived but an hour; still, the partial success of this mode of delivery established the fact, that the vagina could be opened by a laceration of sufficient extent for the passage of a fœtus, without endangering the life of the woman by hemorrhage. Carrying out the method of Thomas, Prof. Alex. J. C. Skene, of Brooklyn, operated in 1874 upon a rachitic subject (who had been forty-eight hours in labor, and had a feeble pulse of 130), with very little better results, as the woman died in seven hours of shock and exhaustion, and the head of the fœtus had been perforated. Satisfied that the plan was a promising one for a favorable case, Dr. Skene again operated, Oct. 29, 1875, upon another rachitic woman, who had been in labor eleven hours, and on this occasion saved both mother and child. He has twice operated since 1875, and Dr. Thomas once, all the women and children being saved.

HISTORY.—My space will not admit of my presenting more than a very superficial record of the past of this operation, which in fact did not previously exist in the precise form in which it has been so successfully performed in the last ten years. In looking back for sixty-five years, we must bear in mind, that the operation devised by Dr. Thomas has three very important objects in view, and that in these consist whatever advantages it may have over other forms of abdominal delivery, viz: 1st. The avoidance of opening the peritoneal cavity; 2d. The avoidance of incising the uterus, either in its body or cervix; and 3d. The escape of the risk of hemorrhage, by lacerating the vagina instead of incising it, except for the initial opening, which is to be made in a carefully selected place, as regards its vascularity.

(1) *Process of Prof. Johann C. J. Jörg, of Leipsic* (1806).—The prevailing idea in the mind of this German obstetrician, was to avoid the risk of incising the body of the uterus. To accomplish this, he proposed to open the abdomen through the linea alba, and then to open the vagina by an incision which could be extended into the cervix, if sufficient space for delivery were not otherwise obtained. He had formed his idea from the escape of a fœtus into the abdominal cavity through a cervico-vaginal laceration, but did not appear to be aware of the fact that an incision of the cervix and upper part of the vagina would provoke a frightful hemorrhage. The operation was never performed.

(2) *Process of Prof. Ritgen, of Giessen* (1820).—Receiving the idea of opening the vagina from Jörg, and that of avoiding the peritoneal cavity from Abernethy's and Cooper's extra-peritoneal methods of ligating the external iliac artery, this German professor proposed to make an incision of the abdomen on the right side, in a curved line from the region of the crista ilii to near the symphysis pubis, at the distance of an inch from the bones, through the skin and muscles down to the peritoneum. This membrane was then to be lifted from the iliac fossa; the vagina to be brought into view, and an opening made into it, through which the fœtus was to be delivered. Like Jörg, he also proposed to incise the cervix in case more room for delivery should be required. In attempting to carry out his plan he operated upon a multipara affected with malacosteon, and proceeded until he came to opening the vagina, which he accomplished with safety; but when, after having made an incision of one and a half inches, he attempted to enlarge it towards the cervix with the knife, there suddenly appeared such a discharge of blood that he felt compelled to desist, and to complete the delivery by the Cæsarean section. The child was saved, but the woman died in fifty-eight hours of hemorrhage from the uterine wound, the uterus having relaxed to a length of eleven inches. Failing in this attempt to carry out a plan of delivery which very nearly resembled that of the present day, Prof. Ritgen formed the opinion that it would be necessary to split the cervix its whole length, in order to obtain sufficient space for the passage of the child. Ritgen's operation, according to his original conception of it, was a true laparo-elytrotomy, designed to avoid exposing the peritoneal cavity and wounding the uterus; but the third important step introduced by Prof. Thomas, for the avoidance of hemorrhage from the vaginal vessels, does not appear to have been thought of.

(3) *Process of L. A. Baudelocque, nephew of J. L. Baudelocque* (1823).—The plan proposed was to incise the abdomen down to the peritoneum in the linea semilunaris, from a point opposite the umbilicus to another two inches above the pubes; then to separate the peritoneum from the iliac fossa by introducing a finger into the lower part of the wound; and next, while one assistant held up the peritoneum and another fixed the uterus, to feel for the arteries surrounding the vagina and to ligate them at both ends. The operator then, with his hand in the vagina, was to force out its anterior wall through the wound, and incise it to the extent of four and a half inches, avoiding the part near the cervix. The delivery was now to be left to nature, or it was to be accomplished by the forceps.

Baudelocque operated twice, his first patient being a rachitic dwarf of thirty-nine inches in height, and having a conjugate of one and three-quarter inches. As soon as he had punctured the vagina a violent hemorrhage ensued, forcing him to tampon with sponges, and to deliver by the Cæsarean section. The child was lost, and the woman bled from both the vaginal and uterine wounds until she died. His second case was one of eclampsia, with a conjugate of nearly four inches. Fearing hemorrhage, he designed to ligate the internal iliac artery, but the assistant letting fall the peritoneum obscured his view of the needle, and he accidentally pricked the external iliac artery, which obliged him to tie the primitive iliac. He then incised the vagina and turned the fœtus, delivering it by the feet. The child was dead, and the mother died in seventy-four hours of septic peritonitis.

(4) *Process of Prof. Philip S. Physick, of Philadelphia* (1824).—This was simply a proposition made to Dr. William E. Horner, the anatomist, and fortunately for Physick's credit was never put into practice. The plan was to open the abdomen by a transverse incision above the pubes; to strip the peritoneum by dissection from the fundus of the bladder, and expose the uterine cervix where it was not covered by serous membrane; and then to incise the cervix so as to give exit to the fœtus. In this operation there was no elytrotomy: it was technically a *subperitoneal laparo-hysterotomy.*

(5) *Process of Sir Charles Bell* (1837).—The incision was to be made as directed by Ritgen, and the peritoneum lifted up from the iliac fossa, so as to reach the vagina or uterus; a small incision was then to be made, a finger introduced, and the parts dilated as in the natural process of labor; the membranes were to be ruptured and the head allowed to advance, or, if required, the fœtus was to be turned and delivered. It is very questionable at this date whether the plan proposed was original, except as to the management of the vaginal opening, which most nearly approaches the vital improvement of Prof. Thomas.

(6) *Process of Prof. T. Gaillard Thomas, of New York* (1870).—This operation, *laparo-elytrotomy*, as it is now generally called, requires for its performance at least four assistants, and better still, five. As it has been performed by five different American operators, I prefer to give the directions which have their collective authority:—

Method of Operating.—As preparatory measures, the patient is to have her rectum and bladder well emptied, and her labor is to be so far advanced that the os uteri is either fully dilated or easily dilatable; the operating room is to be warmed to a temperature of from 75° to 80° Fahr., and it may be carbolized if desirable; the spraying of the patient during the operation is generally considered objectionable. The sponges and instruments, ligatures, etc., to be used, are all to be carbolized, and the abdomen and vagina of the woman may be sponged and irrigated as directed for the antiseptic Cæsarean operation. The operator stands on the right of the woman and makes an incision on the right side of her abdomen, parallel with and a little more than an inch above Poupart's ligament, his chief assistant on the other side of the patient pulling up the skin of her abdomen to render it tense. The incision is to commence at a point one and three-quarter inches above and to the outside of the spine of the os pubis, and is to be carried in a slightly curved direction to a point one and three-quarter inches above the anterior superior spinous process of the ilium, the wound being from four and a half to five inches long. The muscles being gradually cut through to the peritoneum, all arteries that spurt are secured by hæmostatic pincettes, the chief vessel encountered being the superficial epigastric artery. When the peritoneum is reached, it is to be carefully separated from the tissues overlying it to the full length of the wound, and is then to be peeled from the fascia transversalis and fascia iliaca, and lifted up until the vagina is brought into view near its connection with the cervix uteri. The second assistant, at the left of the operator, now introduces his hands guarded with a warm napkin so as not to let the parts slip, as happened in the second Baudelocque operation, and holds up the peritoneum with the intestines overlying it, so as to open the parts to the eye of the operator, while the first assistant, opposite to him, draws the uterus forcibly upward and to the left side, so as to expose the vaginal wall on the right. The third assistant, at the patient's left hip, holds a female catheter in the bladder as a guide, and to lift this viscus from the vagina, while the operator, with a round-ended, wooden instrument, or, better still, with his fingers, forces up the vaginal wall as far as possible into the wound. I say, "better still with his fingers," because experience has shown the value of the touch in avoiding pulsating arteries and large veins.

The next step, and a very important one, is to open the vagina. Dr. Garrigues, of New York, has recommended that this should be done with the thermic or actual cautery, to avoid the risk of hemorrhage as happened in the first Baudelocque case, but experience has shown that this precaution is unnecessary. The opening is to be made by a small incision, as far anterior to the cervix uteri as possible, or about one and one-half inches from it, so as to avoid the ureter and the larger vaginal bloodvessels. When the incision has been made, the index fingers are to be forced through, and then used as opposing tractors to tear the vaginal wall in different directions, care being taken not to open the parts too near to the neck of the bladder. This having been done, the catheter is to be removed, and if the membranes have remained intact they are to be ruptured. The uterus is next to be tilted to the left at the fundus, and drawn backward, while the os uteri is lifted to the right iliac fossa by means of a blunt hook, or, what has been thought preferable, the finger. The fœtus is now to be delivered by the force of the uterus, by turning, by the forceps, or, if dead, by other instruments, and the placenta is to be expelled by expression, and removed through the wound. When the uterus is fully contracted, the iliac fossa should be cleansed by irrigation with warm carbolized water, the stream escaping through the vagina; if any vessels bleed, they should if possible be ligated, but if not, a cylindrical non-conducting speculum may be introduced through the wound and the cautery applied. Persulphate of iron may also be applied per vaginam if found requisite. To test the integrity of the bladder, which has frequently been slightly ruptured, it may be injected with warm milk, as recommended by Dr. Garrigues and since employed by others; if any escape by the vagina, it will readily be recognized by its color. If any rupture is found it should at once be sutured, and a catheter should be kept in until the laceration has healed. These accidents are evidently unavoidable, as they usually occur in the additional stretching of the vaginal rent made by the passage of the fœtus, and have happened where every care that experience could suggest has been exercised. Next, the abdominal wound is to be closed by interrupted sutures of carbolized silk, and dressed antiseptically as after ovariotomy. As the wound will only partially close by the first intention, it has been thought advisable to leave its lower part open, and it has been also recommended to use an abdomino-vaginal drainage-tube.

Laparo-elytrotomy is not difficult of execution if the operator is conversant with the anatomical relations and appearances of the parts to be encountered. Much stress has been laid upon the normal direction of the ureters, and their relations with the uterus, vagina, and bladder, without giving due consideration to the fact, that in the subjects to be operated upon great deformity and displacement of parts usually exist. The operator is obliged to rely much upon his eye and touch, and should be able to use them understandingly. The time required for the operation will vary with the case. The delivery has been accomplished in ten minutes, but it may take the greater part of an hour, particularly if the os uteri be found less dilated than had been expected. In some cases of pelvic deformity, labor will continue for even a day or two without the os being dilated, and the use of Barnes's dilators will have to be resorted to; but in some cases of extreme pelvic collapse even their aid will be inadmissible. If the os has to be dilated digitally after the incision has been made, the time of delivery may be much prolonged. In estimating the applicability of this operation in obstetric practice, we must bear in mind that in a large proportion of the cases in which the Cæsarean operation has been performed, delivery through the cervix has been impossible. This is particularly true of the operations under the old method in the United States. Speculations upon the possibility of operating a second time have been made, and doubts have been expressed as to the feasibility of a left-side operation; but as the latter has been already twice performed upon the living subject without encountering any difficulty, the bladder in neither case having been injured, the question of two operations need no longer be considered. Cases may, indeed, be met with in which an operation on the left side will be greatly preferable, as, for example, where the right hip-joint is anchylosed, the thigh much flexed, and the corresponding ilium flattened and dwarfed; or in a case of scoliosis, with the larger part of the superior strait to the left. For convenience in operating, the left-side incision has been highly recommended by Dr. Taylor, of Cincinnati.

Statistical Record.—Laparo-elytrotomy, after the improved method of Prof. Thomas, has been performed 12 times, 10 of the operations having been in the United States, and nine of these in New York (3) and Brooklyn (6). Prof. Thomas has operated on 2 women; Prof. Skene, of Brooklyn, on 4; Prof. Charles Jewett, of Brooklyn, on 2; and Dr. Thomas W. Hime, of Sheffield, Eng., Dr. Arthur W. Edis, of London, Dr. Walter R. Gillette, of New York, and Drs. Dandridge and Taylor, of Cincinnati, each on one. Six of the women recovered, and seven of the children were saved. In the six fatal cases, one patient was moribund when operated on, and died in an hour; a second had been forty-eight hours in labor and craniotomy had been attempted, her pulse was feeble and over 130, and she died of shock in seven hours; a third (Dr. Hime's) had cancer of the recto-vaginal septum, was a victim of intemperance, and had been bedridden for eleven weeks—she died delirious and violent in two hours; a fourth (Dr. Edis's) was in bad health, and had œdema of the lower extremities—she died in forty hours; a fifth had been four days in labor, and also died in forty hours; and the sixth had been in labor a week, and died of septicæmia in seventy hours. The children of these six women were all lost except in the two English cases. The six women that recovered had been in labor, respectively, 8 hours, 11 hours, 16 hours, 22 hours, 4 days, and a week, and all of their children were saved but that of the last, which had been destroyed by craniotomy and was putrid. The bladder was slightly lacerated in five women, and in a sixth it was opened accidentally with the scissors. Dr. Skene saved three women and their children by his four operations. Of the 12 operations, 3 may be regarded as having been hopeless, and of the 9 others, 5 were quite unfavorable; notwithstanding which, the nine operations saved six women and five children. This last I regard as a fair estimate of the statistical value of the operation *per se.* In comparing its results with the very unfavorable ones of the old Cæsarean operation in New York and Brooklyn, we must remember that all of the subjects of the latter had been in labor over twenty-four hours, except two that recovered, one that was moribund, one whose case was otherwise hopeless, one that was exposed to an outbreak of erysipelas in a hospital, and one whose case was complicated by the existence of a fibroid tumor; the remainder were in labor 2, 3, 3, 3½, and 4 days respectively. Of 11 patients, 2 were saved, who had been in labor 9½ and 24 hours respectively. As laparo-elytrotomy has saved two patients who were in labor four days and a week respectively, we must regard it as better adapted than the old method of operating to save the lives of those whose cases have been rendered in large measure hopeless for the Cæsarean section, with its exposed peritoneal cavity, and, still worse, its wounded uterus.

This operation deserves a special trial in England, where the Cæsarean and Porro-Cæsarean operations have been so largely fatal. It is true that poverty and intemperance make very bad subjects of her women, but the avoidance of the uterine wound promises much better results, as far as we can judge theoretically.

PUERPERAL LAPAROTOMY, OR LAPAROTOMY AFTER RUPTURE OF THE UTERUS.

Delivery of the fœtus by abdominal section as an *elective* measure after uterine rupture, belongs to the teachings of modern obstetrical surgery, and as yet to very advanced views. To perform this operation even when the fœtus must otherwise remain in the abdominal cavity, is also of modern date, and has been very much neglected where it should have been promptly done. But to open and cleanse the abdominal cavity, and, if found practicable or advisable, to sew up the uterine rent, even in cases where the fœtus can be readily removed *per vias naturales* without drawing it back through the laceration, is a still more recent proposition, which has for its recommendation the facts of the dangers of septic poisoning after uterine rupture, as ordinarily treated, and the value of abdominal antiseptic cleansing in the removal of ovarian and other intra-peritoneal tumors. The immediate effect of rupture of the uterus is one of shock, which may prove rapidly fatal. If the exhaustion does not end in collapse, the patient may rally and be in a fit condition to be benefited by the operation; but many women never react so as to admit of it, and many who do are not operated upon; if delivery can be effected *per vias naturales*, they are delivered; if not, they are left to recover or die, as the end may show. Judging from what must be the proportionate number of ruptures in our large cities, counting one case to four thousand births, we are forced to the conclusion that many suitable cases are not dealt with by the knife, but are left to nature entirely; which means that death results in a large proportion that might be saved by laparotomy. This operation has often been confounded with the Cæsarean section, the name given to which by Gardien of Paris, in 1816—that is, "*gastro-hystérotomie*"—fully explains its nature. The two should be kept entirely distinct, as laparotomy is the less fatal; it is rarely performed in the interest of two lives, and the subjects of it are generally much more healthy. The record of the United States shows a higher percentage of saved, and so do some of the European statistics. Dr. Ludwig Winckel saved five out of thirteen Cæsarean cases, and three out of four where laparotomy followed a rupture of the uterus.

Laparo-hysterectomy in cases of rupture has been called the Porro operation, but erroneously, in that it is not "completive of the Cæsarean section." The initial operation was performed in Moscow by Dr. Oscar Prévôt, in Nov. 1878, since which time six others have followed his example, all with fatal consequences. As in regard to the Cæsarean section, so likewise in regard to laparotomy after rupture of the uterus, Dr. James Blundell, of London, questioned, fifty years ago, the advisability of removing the uterus after delivering the fœtus, in these words: "that extirpation of the uterus might be of service, is a question which our better knowledge of abdominal surgery may ultimately prove." And in a later edition (1840) of his obstetrical treatise, he said: "This question may be answered better next century." But after seven fatal cases and no recoveries, this question may be fairly answered in the negative now. Prévôt's patient had a conjugate of four and three-eighths inches, and her uterus bore no evidences of morbid change; nothing could justify an operator in removing the uterus in such a case, since suturing the rent might be done with entire success.

Puerperal laparotomy after ruptured uterus appears to have been one of the neglected operations, and there is reason to believe that, at least in this country, not one case of laceration in a hundred is operated upon. Many, it is true, never react after the accident, but still a fair proportion might be subjected to the knife. The amount of blood lost may not be very serious, or it may be very great, according to the position of the rupture; a lateral tear, or one over the seat of the placenta, may prove rapidly fatal.

Operation.—This is very simple in character, and may be rapidly executed. Care must be taken to avoid the bladder, omentum, and intestines, in opening the abdomen, as the uterus will be found contracted, it may be to a small size. When the fœtus and placenta have been extracted, the clots of blood must be removed, and all the fluid blood and amniotic liquid sponged out, until the parts are well cleaned. Then the uterus is to be carefully examined, and, if possible, the rent closed with sutures, as has been directed for the Cæsarean section. Many women have made good recoveries when the rent has been left open, but it is certainly better surgery to close it up carefully. If the rent is posterior, drainage through the Douglas *cul-de-sac* and vagina may answer as a substitute, but the safety of the woman in a future labor requires that a firm cicatrix should be secured, as instances are on record where rupture has recurred as many as three times, after the healing of the first, when no stitching has been employed. I do not now recall any cases where rupture has followed a Cæsarean operation, in which the uterus has been sutured, although I remember several in which the women subsequently bore children, and one bore two, naturally and without any accident. To save the fœtus would require an immediate operation, such as few men would have the boldness to perform; since in the event of the death of the woman by shock, the fatal result might be attributed to the use of the knife.

It should be laid down, then, as a rule of obstetric practice, that in all cases of rupture of the uterus with escape of fluid into the abdominal cavity, where the woman has reacted sufficiently from the shock of the accident to warrant it, the abdomen should be opened for the purposes of antiseptic cleansing and of suturing the uterine rent; and that this should be done, whether the fœtus is still in utero and can be delivered *per vias naturales*, or has entirely or partly passed into the peritoneal cavity and must of necessity be removed by laparotomy. In no case should the fœtus be drawn back into the uterus and through the vagina, and the woman be then left to nature, in the hope that she may possibly escape death because a few have done so. As the object of treatment is not merely to deliver the woman, but to do all that is possible to save her life, both the uterine and abdominal cavities must be evacuated and cleansed antiseptically, and the rent closed, so that no noxious fluid may escape through it from the uterus.

PUERPERAL LAPARO-CYSTOTOMY, LAPARO-CYSTECTOMY, AND ELYTROTOMY IN ECTOPIC PREGNANCIES.

PUERPERAL LAPARO-CYSTOTOMY.—The removal of an extra-uterine fœtus by opening the abdomen and the containing cyst, is, in its most simple form, a very old operation, the nature of the condition and the propriety of the measure being established by the pointing of an abscess in the abdominal wall, with the subsequent escape of fœtal hair, broken down tissues, and perhaps bones. To deliberately incise a sound abdomen for the removal of a fœtus after its death, is a more modern operation, although one case is on record which dates back to the close of the sixteenth century, the surgeon having been led to operate because one of two fœtal cysts (the woman being pregnant with twins) had previously suppurated, and had opened spontaneously through the abdominal wall. After two such operations there does not appear to have been any until that of Paul B. Calvo, of France, in 1714. To operate for the delivery of a living and viable fœtus is still more hazardous and uncertain, and no attempt of this kind appears to have been made until the beginning of the present century.

The oldest known operation of opening and evacuating a fœtal abscess of the abdomen, is that credited to Christopher Bain, of Castrum Pomponii, and described by John Schenck, of Grafenberg, in 1609, the operation bearing the date of March, 1540. In this case the abscess contained little of the fœtal remains except the skeleton, which was readily removed. Such operations have been very numerous and rarely fatal, the parietal adhesions saving any exposure of the peritoneal cavity.

Laparotomy in cases of extra-uterine pregnancy is divided into two varieties, which are chiefly distinctive in the great disparity of their relative mortality. If the fœtus is living and at a viable age, the operation is denominated *primary;* if it is dead and has been so long enough to affect the placental circulation and its vascular supply, it is denominated *secondary.* If the fœtus is alive, but not yet viable, and if the state of health of its mother appears to demand its extirpation, the case will be primary in its prognostic character, although not strictly belonging to this class of operations. If the fœtal cyst is so connected that it may be ligated and removed as in ovariotomy, the operation becomes one of much less risk, and may be called a *cystectomy.* Should the fœtus die prematurely, its removal may be a secondary laparo-cystotomy, or a cystectomy, according to the form of extraction, either being less hazardous than a true primary operation. While the fœtus is living, if near maturity, the vascular connection between it and its mother, through the placenta, constitutes the basis of risk in its removal, the exfoliation of the placenta giving rise to either a fatal hemorrhage, or to so great a sanious and purulent discharge as to bring the woman to the verge of the grave. After the fœtus is dead, whether mature or premature, a change commences in the placental sinuses, the tissue of the placenta, and the vascular connections between it and its seat, wherever that may be, which in time renders it capable of exfoliation after the removal of the fœtus, without giving rise to hemorrhage, the act of separation being usually more rapid and attended with less discharge than after a non-fatal primary operation, such as that of Mr. Jessop, to be hereafter described. If decomposition of the fœtus should commence soon after its death, the placental changes may take place rapidly, and removal may be safely accomplished in a few weeks (five in one case); but if the fœtus remains sound, twice this time may be required to render the operation safe. Three months after fœtal death may be regarded as a good time for the operation.

According to the researches of Prof. Richard Werth, of Kiel, Germany, made in 1884, there have been 17 true primary operations with 15 deaths, the two non-fatal ones having been performed within ten years. It is true that the late Dr. Parry recorded in his work on "Extra-uterine Pregnancy" 20 "primary" operations with 6 recoveries, but his definition of "primary" does not express the meaning generally attributed to the term, and his six recoveries do not all belong to the primary class, even according to his own understanding of it. As the term is used in this article, not one of his six was primary, as is shown by a careful examination of the original reports. Two of the cases were one and the same, one was evidently uterine, and the other three were unquestionably secondary. In no instance has a woman been saved after a primary operation performed when the fœtus was at full maturity; the two successful operations took place early in the eighth month; I give the reports in abstract:—

Case I.—1875. Operator, Mr. Jessop, of Leeds, England.[1] This case is well known, and I shall only refer to it very briefly. The patient was a quartipara of 26, and pregnant about 7½ months. The diagnosis of her condition was evident, as the feet, nates, and spine of the fœtus could be distinctly felt under the median line of her thin abdominal wall; and the dangers which threatened her life were such that an operation was regarded as imperative. She was emaciated, feverish, and constipated, had a dry tongue, great thirst, and a rapid feeble pulse, and vomited after everything swallowed. The operation was performed on August 14, 1875. The fœtus sat vertically in the abdomen, with its head under the stomach, and there was no trace of a cyst. The placenta covered the pelvis like a lid, and extended upward posteriorly. The child, a female, was living, and did well until eleven months old, when it died of croup and pneumonia. The cord was cut and secured in the lower angle of the abdominal wound.

Bloody discharges commenced after five days, and escaped at the rate of from one to ten ounces a day. On the eighth day the fluid became offensive, being thick, like treacle, dark, and grumous. Vomiting occurred from the tenth to the fifteenth day. The cord was thrown off in twenty-one days, and six or eight ounces of fluid followed its removal. During the fourth and fifth weeks the patient had attacks of agonizing abdominal pain, two, three, and four times in twenty-four hours, which were relieved by an outpouring of coffee-colored putrescent fluid, sometimes to the measure of half a pint, and unbearably offensive. The placental slough came away in a month, at which time for four days there were symptoms of a slight crural phlebitis on the right side. After the placenta came away the discharge became purulent, and gradually diminished in quantity. The wound closed in seventy-six days, and the woman finally recovered her health. She was no doubt saved in her worst condition by being fed by the rectum. The case was treated in hospital.

Case II. 1881. Operator, Prof. August Martin, of Berlin, Germany.[2] I am indebted to Prof. Werth, of Kiel, for kindly sending me the reference to this case. The subject of the operation was 39 years old, and pregnant for the third time; she was moderately robust, and does not appear to have been in any immediate danger, as was Mr. Jessop's patient. Prof. Martin operated on July 9, 1881, when she had been pregnant seven months. When the cyst was exposed, it was found to be crossed in front by a portion of adherent intestine, which required to be dissected off. The fœtus was a male, with a large encephalocele of the occiput, and flat feet. It barely showed signs of life, breathed feebly, and its long, thin cord pulsated. The placental attachments were such that the operator was able to cut off its vascular supply with three ligatures, after which he readily peeled off the placenta and removed it, making the case one of *laparo-cystectomy*, and thus removing the main source of danger. The operation lasted one and a quarter hours, by which time the woman was in a state of moderate collapse, but rallied and made a good recovery, there being no period of anxiety during her convalescence. A drainage-tube was inserted, but removed in a week; the discharges were not offensive at any time. The wound remained open for five months, closing in December. This case was also operated upon in hospital.

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[1] Trans. Obstet. Soc. London, vol. xviii. pp. 261–277. 1876.

[2] Berliner klinische Wochenschrift, No. 52, 26 Dec. 1881, S. 776, 777.

These two operations, it will be noticed, were altogether different in character, and the cases were very unlike in the gravity of their convalescent periods. Neither was an average example of their condition as extra-uterine pregnancies, one because there was no cyst, and the other because it admitted of exsection at seven months. What renders primary laparotomy additionally dangerous, is the variety of location and the intimacy of connection of the placenta, which more than once has been cut into in opening the abdomen. In 1791, Mr. William Turnbull, of London, presented before the Medical Society of that city,[1] a series of drawings representing the appearances of a case which he had examined after death, showing the difficulties that may be encountered in attempting this operation. In his case, when the abdomen was opened, the fœtus was found covered-in by the intestines, the only parts visible being its two hands and the top of its head and face up under the stomach. The prognosis of an operation upon such a case must necessarily be very unfavorable.

Every extra-uterine pregnancy nearing maturity must be an object of special interest, in view of all the risks to be considered, either immediate or in prospect. If the woman is evidently nearing her end, there can be no question about the propriety of operating at once. If she is simply in danger of what may occur when the false labor usual at fœtal maturity comes on, we must consider whether the possibility of the cyst bursting is to outweigh the risk of a primary operation. If we wait until the fœtus is dead, we may lose the patient suddenly, but then it is known that a majority of cases pass over this period of danger in comparative safety. If the woman does escape, she may after a few weeks be operated upon with a fair prospect of entire recovery. But we are told that this is the age of progress in abdominal surgery, and that with antiseptics, drainage, and irrigation, we ought to be able to save a primary case, and that past statistics should not weigh against our attempting to save two lives rather than one. This is certainly a tempting consideration, and no doubt trials will be made in the near future, but we must not be too sanguine in making a prognosis. Take a case like this, for example: In October, 1875, three prominent Philadelphia obstetricians met daily in consultation for sixteen days over the case of a lady who was suffering the pains of false labor, in the effort of nature to discharge an extra-uterine fœtus which was alive during their early visits. As they could not promise the husband that an operation would probably save the life of his wife, they waited for the time to come when they could do this; but while doing so, and when the lady appeared to be getting better, she was suddenly seized with agonizing pains followed at once by a state of collapse, and died in thirty minutes. There was no autopsy, but after similar symptoms in other cases, there has been found either a laceration of the cyst or a large hemorrhage into it. Other experiences similar to this might be given, but this one is sufficient on which to base the question: should a primary operation be attempted in such a case? Should such a case and question be submitted to a body like the Obstetrical Society of London, widely opposing opinions would be brought forth.

Mr. Lawson Tait recommends that we should make an exploratory incision into the abdomen and examine the character and connections of the fœtal cyst, to determine whether the operation can be completed without too much risk. This would require a long incision; and without the removal of the fœtus it would be impossible in some cases to determine the feasibility of ligating and exsecting the entire growth; besides, the condition of the patient, as was that of one I saw recently, might render such an exploration one of great gravity. Prof. August Martin proposes to transfix the placental connections with needles, threaded with heavy ligatures, and, having tied the latter, to remove the placenta and cyst. We must, however, consider that there are three chief forms of extra-uterine pregnancy, viz., *Fallopian*, *ovarian*, and *abdominal*,[1] and that the most common, and the most difficult to save, is the last. In quite a number of secondary laparotomies, the possibility of ligating and exsecting the entire fœtal mass has been proven, as will be shown hereafter.

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[1] Memoirs Med. Soc. Lond., vol. iii. pp. 176–214. 1792.

LAPARO-CYSTECTOMY.—Since the electro-magnetic current has been discovered to be so safe and efficient a fœticide in the incipiency of extra-uterine pregnancy, many cases have been cured, and thus the later question of what to do with the fœtus has been set at rest. Many cases, however, are not examined or recognized until the fœtus is too much grown to make this plan of treatment advisable, as when dead at four months or more, it becomes liable to decomposition, and may thus be a centre of danger. *Laparo-cystectomy* may here present itself as somewhat less dangerous than an operation nearer the time of maturity of the fœtus. If the whole mass can be ligated and exsected, the operation becomes not only one of far less risk, but the recovery of the patient will be much more rapid.

PUERPERAL ELYTROTOMY, improperly named the "vaginal Cæsarean section," as neither abdomen nor uterus is incised, has been several times performed with success, even at the full maturity of the fœtus, the children being delivered alive by the forceps. What is denominated the *intra-ligamentary* or *extra-peritoneal* variety of pregnancy, is the best adapted to an operation through the vagina. In this peculiar form, the fœtus is inclosed within the two layers of the broad ligament, the ovum, originally in the Fallopian tube, having passed through its lower wall and become developed beneath it, and extending upward from the postero-lateral part of the pelvis into the abdominal cavity, the original Fallopian cyst being still a part of the fœtal inclosure and connected with the placenta. When such a sac is opened by elytrotomy, and the fœtus removed, the placenta may be peeled off with little hemorrhage, but as the contrary may take place, it is much more prudent not to try the experiment. In 1816, Dr. John King,[2] of Edisto Island, South Carolina, saved both mother and child by this operation, and removed the placenta, but no mention is made of hemorrhage. In 1881, Dr. J. H. Mathieson,[3] of St. Mary's, Ontario, had a like success, the living fœtus weighing eight pounds seven and a half ounces. He also removed the placenta, which was readily separated from the posterior left side of the cavity, and presented the peculiar form of three lobes. There was not much hemorrhage, and what there was ceased under the introduction of a sponge soaked in a solution of perchloride of iron.

In another form of post-uterine gestation an operation is much more dangerous. The late Dr. Albert H. Smith, of Philadelphia,[4] in 1878, opened a fœtal cyst through the Douglas *cul-de-sac* by means of Paquelin's thermo-cautery knife, and in doing so cut through the placenta and brought on a profuse hemorrhage. When this was checked by a partial removal of the placenta, he was obliged to pass his hand into the abdominal cavity in search of the fœtus, which was in the region of the transverse colon on the left side. There was no true cyst, but the fœtus had been inclosed by an agglutination of the uterus and neighboring organs around it, and had escaped by the adhesions having given way. The woman died of exhaustion and commencing peritonitis in eighty-six hours. Prof. D. Hayes Agnew, of Philadelphia, operated in a somewhat similar case, at least in the fact that there was no closed enveloping cyst. When the patient was doing well and in a fair way to recover, eight days after the operation, an accoucheur injected into the cyst, to cleanse it, a weak solution of permanganate of potassium, which brought on at once a violent pain, set up peritonitis, and caused the patient's death in twenty-four hours. The fœtus in this case was dead, and was computed to weigh ten pounds; the placenta was removed without hemorrhage.

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[1] These are shown by their early history to have been primarily Fallopian in a large proportion of cases.

[2] New York Med. Repos., p. 388. 1817.

[3] Lancet, May 24, 1884, p. 940.

[4] Am. Jour. Obstetrics, vol. xi. p. 825. 1878.

Prof. T. Gaillard Thomas, of New York, in 1875,[1] operated on a lady believed to have been pregnant three and a half months, and opened the cyst with an incandescent galvano-cautery platinum knife, removing a fœtus six and a half inches long. In attempting to remove the placenta he excited so severe a hemorrhage that he was forced to desist, tear away the separated half, and inject a solution of the subsulphate of iron. Symptoms of septicæmia appeared on the fourth day, and were subdued in a week by frequent injections of carbolized water. On the seventh day there was some hemorrhage. On the fifteenth day the remnant of the placenta came away. On the sixteenth day an embolus and small abscess appeared in one arm, and phlegmasia dolens threatened. In six weeks the opening of the cyst closed up, and in ten the patient was fully restored.

These few cases show the difficulties and risks of this form of operation. The vagina should be opened by a galvano-cautery applied through a large hard-rubber speculum, the parts to be incised being brought down by tenacula; and the placenta should not be removed unless softened by partial decomposition, for fear of bringing on hemorrhage.

Secondary laparo-cystotomy has been performed a large number of times during the last decade, and with very encouraging results. The general rules for the operation are to open the abdomen as for ovariotomy; to open and evacuate the cyst; to cleanse the same with carbolized sponges and stitch it to the uterine opening, sewing both together and leaving the placenta *in situ*, with the cord hanging out at the lower angle of the abdominal wound; and, finally, to insert an abdominal drainage-tube and dress the wound antiseptically. What to do with the placenta has been long a trouble to operators. To let it alone is the general rule; but this direction does not satisfy the progressive surgeon. Can we not get rid of this great fleshy mass which is to decompose, exfoliate, and possibly poison the patient? Yes, in a few cases, but much must depend upon the seat of the placenta, and upon the possibility of ligating its vascular connections; otherwise its removal will prove fatal by hemorrhage, as it generally did until operators learned through Dr. James Mease and Mr. William Turnbull to let it alone. The records of a few cases will show that in some instances the whole fœtal cyst may be removed in the operation, or the placenta be entirely or partially taken away:—

Case I.—Feb. 7, 1880. Prof. Egidio Welponer, of Trieste, reports a case[2] in which a full-grown fœtus was removed after it had been carried two years and three months. The cyst had formed adhesions with all its surroundings, which were carefully dissected free, showing a pedicle on the right side, which was ligated, cut, and dropped in. The right Fallopian tube was found to communicate with the cyst-cavity, the walls of the tube merging into those of the sac. The woman made a good recovery.

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[1] New York Med. Journ., pp. 561–569. 1875.

[2] Archiv für Gynäkol., Bd. xix. 1882.

CASE II.—Oct. 14, 1880. Prof. Litzmann, of Kiel, Germany,[1] had a similar experience. The patient, a primipara of 35, carried the fœtus nine months over time, until the amniotic fluid had nearly all been absorbed. The sac was here and there adherent to the omentum and abdominal parietes; these attachments being separated, and some of them tied, the sac was found to spring by a broad pedicle from the right broad ligament; this was ligated and the cyst cut away, after which the stump was dropped in. The woman made a good recovery, and was discharged in eighty days; the pregnancy, after examination of the exsected parts, was regarded as tubal.

These cases were properly secondary laparo-cystectomies, and go to prove that, by careful isolation, it is possible to treat a fœtal cyst like a solid ovarian tumor, in perhaps more instances than is generally credited.

CASE III.—June 5, 1884. Prof. T. G. Thomas, in an operation of this kind, finding the placenta of enormous size, determined to reduce its bulk.[2] It was attached to the transverse and descending colon. After removing a large male fœtus he tied the placenta, and then cut away as much as was considered safe, after which he puckered together what was left, like a bag, and sewed it into the abdominal wound. The woman had an attack of acute septicæmia, but recovered in six weeks.

CASE IV.—Feb. 28, 1882. Mr. J. Knowsley Thornton[3] removed a fœtal cyst entire, which had been thought to be a fibroid; it contained a small dead fœtus, and a large hypertrophied placenta. The uterine attachment was ligated and the pedicle dropped in; the cyst was believed to be a tubal one. The woman recovered.

These short abstracts of cases show, in few words, the great uncertainty of all operations upon extra-uterine cysts. As the placenta may be implanted anywhere, the fœtus encysted or not, and the whole mass impossible or on the other hand quite possible to isolate, we cannot tell until after exploration what may be the probabilities in any given case, and each one must be a law unto itself. That the secondary operation can be managed with comparative safety, is shown by the fact that Dr. Thomas saved all of his four cases, and that Mr. Lawson Tait lost but one out of seven. Other operators have likewise been quite successful, as for example Prof. August Martin, of Berlin, already mentioned.

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[1] Archiv für Gynäkol., Bd. xviii. 1882.

[2] Am. Journ. of Obstetrics, Oct. 1884, p. 1063.

[3] Trans. Obstet. Soc. London, March, 1882.

OVARIAN AND UTERINE TUMORS.

BY

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OVARIAN TUMORS.

FOR clinical and all practical purposes ovarian tumors may be conveniently divided into two groups: cystic and solid tumors. The former of these—by far the more important—comprises ovarian cysts, dermoid cysts, cysto-fibromata, cysto-sarcomata, and cysto-carcinomata. The latter includes true fibromata, sarcomata, papillomata, and carcinomata of the ovary. In the following pages these will be considered in turn, and their pathological and clinical characters will be briefly laid before the reader.

I. OVARIAN CYSTS AND CYSTOMATA.[1]

ORIGIN.—In no branch of surgery has the last decade been more fruitful than in practical suggestions for the improvement of ovariotomy; in few or none has our knowledge of the origin of disease made less progress than in regard to the causation and mode of production of ovarian cysts. Schroeder, writing in 1873, says: "Very little is as yet definitely known concerning the origin of ovarian cysts; we will only say . . . . that, while it is possible to comprehend the etiology of dropsy of the Graafian follicle, we yet know nothing definitely with regard to the origin of a true cystoma." Thomas, in 1880, says that "pathologists are still at variance with reference to the origin of ovarian cysts," and assumes that they may be generated either from the Graafian follicle, as taught by Rokitansky, Wilson Fox, and Rindfleisch, or from the ovarian stroma alone, as held by Waldeyer, Wedl, and Lücke. Emmet, in 1884, while committing himself to no explicit theory of their formation, quotes with approval Waldeyer's description of follicular and compound cysts. Finally, Noeggerath,[2] in 1880, was led by his histological examinations to conclude that proliferating ovarian cysts were "to a large extent the result of a degeneration of ovarian bloodvessels."

CAUSES.—We know as little of the causation as of the origin of ovarian cysts; and it can only be affirmed with certainty that middle age, that is, the period of menstrual life of a woman, is a predisposing cause, while all kinds of prolonged ovarian irritation act as exciting causes of this disease.

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[1] Thomas (Diseases of Women, p. 673, note. 1880) defines a cyst as "a collection of fluid enveloped within a pre-existing sac;" a cystoma as "one which creates its own sac."

[2] American Journal of Obstetrics, January, 1880.

Morbid Anatomy.—The simplest and most elementary form of ovarian cyst is dropsy of the Graafian follicle, *hydrops folliculi.* This is usually small in size, and found only in autopsies; its size varies from that of a pea or a cherry to that of the fœtal head, and in very rare cases its growth distends the abdominal cavity. These cysts are often congenital, and have been found at all ages after birth. At first their structure is analogous to that of the Graafian follicle—an external fibrous coat derived from the ovarain stroma, and a thinner internal coat lined with epithelium, which corresponds to the tunica propria of the Graafian follicle. This wall varies greatly in thickness in different parts of the cyst; at some points extremely thin, at others dense and opaque. The contents of these cysts are usually a clear, limpid serum, with an ovum sometimes floating or attached at some point of the epithelial lining, which is smooth and without projecting septa. This condition was described thirty years ago by Rokitansky, and more lately by Ritchie in specimens removed by Spencer Wells, by Webb, and by others.

Schroeder regards these formations as so-called "retention-cysts," and ascribes their origin "to the causes which hinder the rupture of the follicle" and the escape of the ovum. Hyperæmia, congestion, or inflammation of the follicular coats, is the usual agency in this case, and its influence may be traced in the induration and thickening of the cyst-walls. But in congenital cases, and in infancy, the disease must be due to a hyper-secretion of the fluid of the follicle, for no liquor folliculi has been found within the Graafian vesicle at this time of life. In many cases, Schroeder thinks that the follicle may be obliterated as the result of previous inflammatory processes, while the secretion remains, and thus leads to the formation of a cyst. Though usually difficult of demonstration, from the delicate nature of the tissues involved, he instances one case in which Chrobak found a retention-cyst of the follicle after a pre-existing peritonitis.

Ordinary ovarian cysts and cystomata are, however, much more complex in their histology and in their mode of origin. In an able and elaborate memoir, contributed to the Royal Medical and Chirurgical Society of London, in 1864, Dr. Wilson Fox endeavored to show that these growths might originate in the Graafian follicle. But this view has of late years been systematically opposed, and most pathologists now follow the lead of Waldeyer,[1] who regards all these growths as epithelial tumors, and traces their origin to the glandular parenchyma of the ovary. This is formed by the in-growth into the connective-tissue stroma of the epithelium which lines the mucous membrane covering the ovary, thus constituting the glandular follicles. These latter are really the preliminary structure from which are developed both Graafian follicles and all cystoid growths of the ovary. This change may occur at any period of life, many cases being recorded in infancy, and a few, as by Slavjansky[2] and Koster,[3] in women over thirty years of age.

The formation of the cystoma from the glandular follicles is as follows: the epithelial cells "lying nearest the centre become softened, liquefy, and form the contents of the cysts, while from the walls of the small cyst, formed in this way, arise other glandular pouches. According to this simple plan are developed all the complicated forms of the cystic tumor of the ovary. The original cyst consists of a membrane—which is really nothing more than the condensed ovarian stroma—of epithelium lining the interior of the cysts (originally the epithelium of the glandular pouches), and of fluid contents which are partly a simple transudation from the blood, and partly metamorphosed epithelial protoplasm" (Schroeder).[4]

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[1] Archiv f. Gyn., Band i., Heft 2, S. 252.

[2] Annales de Gynécol., Fév. 1874, p. 126.

[3] Virchow u. Hirsch's Jahresbericht, Bd. i., S. 52. 1872.

[4] See, also, Doran's "Clinical and Pathological Observations on Tumors of the Ovary" (London, 1884), where a vast amount of exact information on this subject will be found.

Fusion of many of these minor cysts into one, and progressive development of the cyst-wall, are the chief factors that produce important changes in simple cysts. Fusion of two or more cysts into one is due to the gradually increasing pressure on their intervening walls, which is a natural consequence of their growth. This finally causes perforation; and, the pressure continuing, the opening constantly increases, until at last the smaller cyst forms simply a nodule in the wall of the larger, the former partition-wall contracting into flat septa which project into the cavity. Thus many cysts may merge into one "unilocular" cyst of large size, which, according to Waldeyer, is always thus formed—the original type being multilocular, and the final resultant unilocular.

As development progresses, numerous changes in the cyst-walls also occur, and impress varying characteristics upon the cystoma. These depend usually upon the comparative development of the epithelium and of the connective-tissue elements. In the former case, new glandular follicles or blind pouches are developed upon the interior of the cyst-wall; these rapidly undergo cystic degeneration by dilatation, and from their surface other follicles sprout which likewise become cystic. Thus an exterior new formation is developed in the cyst-wall, proliferating in all directions, merging into the interior parent cyst with which the breaking-down walls of the new growths here and there communicate, and finally producing the minute, honeycomb formation so often met with in ovariotomy. This is the so-called glandular proliferating cyst, or *cystoma proliferum glandulare*, of Waldeyer.

In the *cystoma proliferum papillare*, the opposite condition, hypertrophy of connective-tissue elements, predominates. Here mucous villi, or vascular sprouts of the connective tissue of the inner layer of the cyst-wall, push forward the epithelium into the cyst-cavity, forming papillæ—sometimes minute, slender filaments, sometimes thick masses which ramify in every direction—and filling the entire cyst-cavity. More rarely they perforate the main cyst-wall from the excessive pressure exerted from within, and sprout into the abdominal cavity. Growths of this class seldom form adhesions to neighboring parts, which Waldeyer and Emmet attribute to the peculiar nature of their epithelium, made up of cylindrical cells; this possesses many of the qualities of mucous membrane, as long as the tumor remains intact. Friction against the abdominal walls gradually destroys the epithelium, however, and then adhesions may occur as in ordinary tumors.

These two varieties of cystoma may also combine, and thus lead to the development of the most various forms. In the main, however, two layers compose the walls of all principal cysts, and, occasionally, of the larger secondary cysts, viz., a highly vascular internal stratum, composed of proliferating cells and lined with epithelium, and a much thicker layer of somewhat dense connective tissue. Eichwald dissents from Waldeyer's opinion that the epithelium is always cylindrical, having demonstrated pavement epithelium in a few cases, while in others ciliated epithelium is said to have been discovered.

The contents of ovarian cysts vary in every degree between a gelatinous fluid, dense as the thickest jelly, and a thin, limpid, but viscid liquid. This is serous, highly albuminous, and varies in color from a pale yellow to a dirty yellowish-green, or brownish-red; not infrequently it is bloody or sero-purulent. In parovarian cysts alone are the contents quite clear, watery, and very slightly albuminous. The thick gelatinous fluid is thought by Schroeder to be "composed of glandular cells which have undergone a colloid degeneration, and have been afterwards separated and dissolved in the serous exudation."

Eichwald,[1] who has made most elaborate studies of the histology of cyst contents, divides the fluid contents into two distinct groups, mucous and albuminous. The elements of the first will be found predominant in young cysts with thin fluid, those of the second in the contents of old colloid cysts.

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[1] Colloidentartung der Eierstöcke, Wurzb. med. Zeitschrift, 1864, S. 270, u. folg.

(1) The first class consists mainly of mucous elements, variously altered, formed during a process of colloid degeneration, which, in reality, is a mucous metamorphosis, and in the course of which are developed—

Mucine, insoluble (but hydrated) in water.
Muco-peptone, easily soluble in water.
Colloid substance, made turbid by acetic acid.
Matter of colloid corpuscles, precipitated by acetic acid, soluble in dilute alcohol.

(2) The albuminous group contains albumen in the two forms of free albumen, and albuminate of sodium; the latter coagulable only by acids. In colloid tumors, albumen undergoes a gradual alteration into, first, paralbumen, coagulable by acids, but not by heat; then into metalbumen, not coagulable by acids; and finally into albumino-peptone. This is analogous to the process of digestion.

The elements of this group are therefore—

Albumen.
Paralbumen, } transitional states of pure albumen.
Metalbumen. }
Albumino-peptone.

All of these contain traces of sulphur, and are precipitated from free solutions by neutral metallic salts.

A clear and concise digest of Eichwald's views is given by Thomas.[1]

The microscopy of ovarian cyst contents was carefully studied ten years ago by Koeberle[2] and Thornton;[3] and has been more exhaustively investigated of late by Drysdale[4] and Garrigues.[5] Drysdale still maintains the value and diagnostic importance of the "granular ovarian cell," long associated with his name; while Garrigues thinks that the "most important elements in regard to diagnosis are columnar epithelial cells seen in side view," and adds that "Bennett's corpuscles, Drysdale's corpuscles, nuclei with dark granules, and cholesterin, have no diagnostic value." The issue of this controversy is still undecided; and for the earlier and more elaborate history of the subject the reader is referred to the standard works of Wells, Atlee, and Peaslee.

Course and Natural History.—The tendency of ovarian cystomata, if unchecked, is to grow more or less rapidly until the whole abdominal cavity is filled, after which they "distend its walls, encroach upon the thoracic cavity, press up the abdominal and thoracic viscera, and finally cause death by interfering with the nutrition of the body and the functions of the vital organs" (Williams).[6] This, broadly stated, is the rule; but so various are the changes which affect the development of ovarian cysts, that, in practice, the rule is less important than the exceptions. Interruption to the growth of the cyst may occur from several causes; spontaneous absorption, with rupture of the cyst-walls, is known to have occurred in a limited number of cases. Years ago, Dr. Tilt, of London, collected and published between 70 and 80 of these cases, of which the majority were either cured or improved. When the rupture occurs into the peritoneal cavity, this, however, can only be true of parovarian cysts, or of ovarian cystomata with unusually bland fluid; otherwise nothing is more usual in the history of ovarian disease than for peritonitis and death to result from such an accident. Should the fluid be thick and irritating, as that contained in polycysts usually is, fatal peritonitis is an almost certain result. More often, in case of rupture, the contents are discharged into neighboring organs. Here preliminary adhesions form between the cyst-wall and the organ adjoining, and ulcerative perforation occurs from pressure at the point of union. Thus, in recorded cases, the cyst-contents have escaped into the intestines, the bladder, the Fallopian tubes, and the vagina, below, and upwards into the stomach, the pleural cavity, and the lungs.

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[1] Op. cit., p. 686.
[2] Archiv für Gyn. 1875.
[3] Med. Times and Gazette, 1876.
[4] Trans. Am. Gyn. Society, 1877 and 1882.
[5] Am. Journal of Obst. 1882.
[6] Reynolds's System of Medicine, vol. v.

Occasionally, extensive hemorrhages occur within the cyst-cavity, an accident most commonly seen in papillary cystoma, from the great vascularity of the papillæ. Traumatic causes and twisting of the pedicle also lead to this unfortunate complication. If the latter occurs slowly and gradually, partial or complete atrophy of the cyst may result, or the pedicle may give way, and the tumor become free in the abdominal cavity, or form attachments to other organs and continue to grow; if rapidly, the veins of the pedicle are chiefly affected, the return of blood from the tumor is interrupted, and the intracystic hemorrhage is greater or less in accordance with the size of vessels that give way under the pressure.

Often the cyst undergoes inflammation, either from causes affecting its nutrition, or from accidents or injuries from without. This may produce ulcerative perforation of the cyst-wall with consequent escape of its contents, or a puriform condition of the cyst-fluid. In the first case, septic peritonitis at once results. In the second, gradual septicæmia, which is frequently fatal unless ovariotomy is promptly performed.

Where none of these changes occur in the cyst, death sometimes results from simple asphyxia, due to prolonged pressure of the ascending mass upon the thoracic viscera.

SYMPTOMS.—The symptoms of ovarian cysts are both rational and physical. The important rational signs differ with the position and gradual development of the tumor, whether pelvic or abdominal, and vary greatly in different individuals.

Usually, when the cyst is small, its presence is unnoticed, but often there is a sense of weight and bearing down in the lower abdomen, vesical tenesmus, and pain in micturition, some interference with the functions of the rectum (although this is rare), and frequently dysmenorrhœa. Menorrhagia or metrorrhagia is usual. If the cyst be adherent to the pelvic walls, or inflamed, all these symptoms are aggravated, with the addition of much pelvic pain, often reflected to neighboring parts of the body, as usual in ovarian neuralgias. As fluid accumulates within the cyst, its adhesions become more distended and tender, defecation is painful, locomotion and every movement of the body is attended with discomfort, and dysmenorrhœa becomes a prominent source of complaint. In these cases the patient rapidly becomes an invalid, and I have on two occasions been compelled to remove inflammatory cysts no larger than an orange, on account of the constant and intense discomfort which they caused.

As the cyst, when unimpeded by these conditions, rises into the abdominal cavity, the symptoms which it causes are quite different. In the majority of cases, the patient now for the first time becomes aware of its presence, either as "a lump in the side," or by the commencing abdominal enlargement. Hence, at this stage, the surgeon is first consulted in all those instances in which the early development has been free from pelvic discomfort.

The prominent symptoms are now due to pressure of the enlarging mass upon the neighboring abdominal organs. Constipation results from pressure on the lower intestines; renal disturbance, and often albuminuria, from direct compression of the renal bloodvessels; crural neuralgia, or vague neuralgic pains in the lower extremities, from pressure on the pelvic nerves.

At this period of development, the cyst usually fills the right or left iliac region, and is easily perceptible when the patient lies recumbent, and the abdominal walls are relaxed. Its position is rarely central, although cases are sometimes met with where the mass ascends from the first in the median line, pushing the uterus forward upon the pubis or back into the hollow of the sacrum.

Gradually, however, unless early adhesions exist, the development of the cyst becomes more central, until it fills the whole lower abdomen as high as the umbilicus. It is at this stage that ovarian cysts have often been mistaken for pregnancy; especially if the cyst-wall be thick and tense, and in the limited class of cases where many of the sympathetic disturbances of pregnancy coexist—blueness of the vagina, morning sickness, and mammary enlargement, with perhaps the presence of some milk in the breasts. Two distinctive signs of exclusion can, however, always be obtained by the careful diagnostician: although the uterus be enlarged, the cervix is never typically soft, and no sensation approaching that of true ballottement can be obtained. No caution can, however, be too great in pronouncing a final opinion in such circumstances, and the want of it has led to many deplorable results.

As development advances, the liver and stomach suffer increasing compression, and dyspeptic symptoms rapidly supervene; constipation becomes more obstinate, the general health deteriorates, the patient is emaciated, and often amenorrhœa is observed. At a still later period, the thorax is affected by the upward growth of the cyst; the lower ribs are pushed out, the diaphragm is elevated, the heart and lungs are compressed, and constant interference with the functions of these organs results. The patient now becomes short-breathed and feeble; and death closes the scene, either from the progressive increase of these conditions, or by the advent of some comparatively trifling intercurrent disease.

The *physical signs* of ovarian cysts are yet more important than the rational, and, indeed, constitute the sole basis upon which a diagnosis can rest. Formerly these were obscure and doubtful, and the imperfect methods adopted led to an apparently insuperable barrier to obtaining accurate results. At the present day, thanks to the unwearied efforts of Spencer Wells in England, of Atlee and Peaslee in this country, and of a host of intelligent investigators in every land, the diagnosis of ovarian cystoma is as accurate as that of lobar pneumonia; and errors, which, a generation ago, were of daily occurrence, are in the hands of an expert now inexcusable.

The methods of physical exploration by which the crucial test of an ovarian cyst is reached, are thus tabulated by Thomas,[1] in a chapter so admirable that every student of this subject should familiarize himself with it:—

Inspection and Manipulation.
Mensuration.
Palpation.
Percussion.
Auscultation.
Vaginal touch.
Rectal touch.
The Uterine sound.
Aspiration or Paracentesis.
Chemical and Microscopical examination of the Tumor.
Explorative incision.

If it be asked, is it always necessary to resort to these numerous and seemingly redundant methods to diagnose an ovarian cyst, the answer is obvious.

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[1] Op. cit., p. 702.

For an expert ovariotomist, and in simple cases, it is not. In obscure or complicated cases not one of these tests can be safely omitted, and to the inexperienced surgeon they are always necessary. It is a truism that "fools rush in where angels fear to tread," and he who has learned by long experience how imperfect is his knowledge, will be the last to neglect any aid, however slight, in forming a certain diagnosis.

In every case, the conscientious practitioner will endeavor to verify his opinion by the combination of all these tests except the three last enumerated, and, possibly, auscultation, which is of value chiefly when a suspicion of pregnancy has arisen.

In the application of the first of these means of diagnosis, and throughout the entire examination, the patient is placed in the recumbent position upon a firm table or other resisting surface, with the knees drawn up, the abdomen exposed, and all constricting clothing about the waist removed. If the supposed cyst has passed the first stage of development and has risen into the abdominal cavity, a lateral or central enlargement of the abdomen will be perceptible, but rarely as a tumor with definite outlines. The hands are then placed flat upon the abdominal surface, and steady pressure is made downward towards the spine, and from side to side, while the patient's attention (if she be nervous or alarmed) is diverted by questions about her symptoms or antecedent history.

By this means the swelling, if cystic, will be felt as an elastic, resisting mass, movable perhaps from side to side, but not to be displaced by firm pressure; if due to accumulations of fat, the feeling will be doughy, and the fingers are gradually felt to approximate the spine; while if caused by gaseous distention of the intestines, the movement of flatus will soon be felt, and can be otherwise identified, as will be more fully stated hereafter.

In advanced stages of cystic growth, and especially in cases of polycystic tumor, the abdominal appearance is almost pathognomonic of ovarian disease without the application of further tests. The abdomen is enormously distended, the superficial veins are enlarged in all directions, the false ribs are pushed out, and the epigastric region is made prominent by the encroaching growth, the upper and lateral outlines of which are often irregular, while, in spite of the immense pressure, the umbilicus is flat, or even retracted, instead of protuberant as in ascites. Distinct fissures or *sulci* are sometimes apparent to the eye, and more often to the touch, indicating the lines of demarcation between the several parts of a polycystic growth. In these cases the existence of a "tumor" is of course obvious, for simple ascites never presents such characters; and the object of examination becomes at once the differentiation of this tumor from other morbid growths, such as malignant disease of the omentum or peritoneum, which might possibly cause the appearance described. This differentiation is occasionally, although rarely, a matter of extreme difficulty.

Mensuration is of advantage chiefly in the early stage of ovarian tumors, when the growth occupies one iliac region; or in polycysts at any period of development. Here, measuring accurately from the sternum, or umbilicus, to the iliac crests, will show a marked difference on the two sides, which never occurs in abdominal dropsy. This, however, is its chief value, as all abdominal tumors would evidently cause the same discrepancy.

Palpation and *percussion* are always combined with the first named method of investigation, and serve to establish the outline of a tumor, and the sense of fluctuation if fluid be present, and to exclude gaseous distention of the intestines or peritoneum. An ovarian cyst is elastic when compressed, and dull on percussion.

Auscultation mainly aids in excluding pregnancy, although it is also of value in a few cases by enabling us to ascertain the aortic bruit, which cystic tumors indistinctly transmit, while solid formations, like fecal impactions or omental growths, conceal it. This statement, however, requires modification in the case of uterine fibroids.

Vaginal touch is a most important means of diagnosing ovarian cysts, and, in recent growths, is indispensable. While confined to the pelvis, the outlines of a small cyst can often be accurately mapped out from the vagina. Here the sensation imparted to the finger is that of a round, elastic mass, to the right or left of the uterus, its perfectly smooth surface easily distinguishing it from the irregular, nodular outline of a fibroid; it is less dense and resistant than the latter, readily separable from the womb and not moving with it, and conjoined palpation gives a distinct sense of fluctuation when the abdominal walls are thin. This manipulation is painless unless inflammation has occurred in the cyst-wall, or around it; but, as a rule, it is only in the latter case that the patient is apt to apply for advice at so early a period. Afterwards, when rapidly accumulating fluid distends the cyst-walls, the posterior cul-de-sac is pushed downward, and either in the vagina or rectum fluctuation is rendered distinct by percussion over any part of the tumor. In no form of ascites is the fluctuation in the cul-de-sac comparable to that caused by a tight cyst.

Rectal touch being practically the same, and merely corroborative of the method last described, need not be separately considered; but in thorough clinical examinations it should never be omitted.

The employment of the *uterine sound* is also most important. By it alone can we ascertain the depth of the womb, the nature of its contents, if there be any, and its mobility in relation to the tumor. The rule is uniform that, in ovarian or parovarian cysts, the normal depth of the uterus is unaltered; in cases of fibro-cyst or uterine fibroid, it is very considerably increased. Exceptions to this doubtless occur in practice, and to the expert in ovarian disease the sound is not always a necessity; but the general surgeon should never omit it. At the same time, the utmost caution and delicacy should be observed in its use, and all rough manipulation should be avoided. I can recall more than one case where its repeated use by different consultants has caused serious injury before an intended ovariotomy. In the Woman's Hospital, in New York, it is customary to request that the employment of the sound shall be omitted, if practicable, in a consultation.

Aspiration of the cyst, by simple puncture or by paracentesis, is most important in cases where palpation and percussion fail to distinguish between a supposed cyst and ascites, or between a cystoma and encysted fluid of other origin. Here examination, chemically and by microscopical tests, is of the utmost aid in diagnosis; and it should never be omitted in these rare instances.

Various aspirators have been devised for use in these cases, notably Emmet's,[1] an ingenious modification of Dieulafoy's large instrument, which is cumbrous and expensive. But since Dr. Walker, of New York, proposed, in 1870, to use the simple hypodermic syringe, this alone is resorted to when only a small amount of fluid is desired. A syringe, rather larger than that in common use, holding from a drachm to an ounce, is fitted to a fine hypodermic needle, and with this a sufficient amount of fluid may be withdrawn from several points of the cyst. But if the fluid be colloid, this effort is useless. Then a larger needle is fitted to either Dieulafoy's or Emmet's aspirator, and the fluid withdrawn by more powerful suction. With either of these instruments a small cyst may be entirely emptied of its contents.

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[1] Principles and Practice of Gynæcology, p. 686. 1884.

The puncture is commonly made in the median line, and inflicts little or no pain. But, simple as this proceeding seems, it is not devoid of danger. In many cases the irritation and unequal pressure of the cystoma upon the peritoneum predisposes the patient to peritonitis, which the puncture of even a fine needle is sufficient to develop; and in the American Journal of Obstetrics for 1876, Dr. Mundé reports four authenticated cases of death from this cause. Others are on record, both in Europe and in this country; but these suffice to establish the necessity for extreme caution in resorting to aspiration. Ten years ago, Dr. Peaslee, whose vast experience and methodical mind entitle all his opinions to respect, in discussing this subject, declared that he thought the aspirator quite as dangerous as the trocar. Although the reasons for dissenting from this opinion are too obvious to require mention, the fact that it was held by so thoughtful an observer, is significant. Among the lesser dangers attending it are simple peritonitis and septic fever with decomposition of the sac contents, as reported by Thomas, Goodell, Thornton, Skene, Schroeder, and others.

Paracentesis or *tapping* is still more liable to subject the patient to the dangers just enumerated. It will be considered fully under the head of palliative treatment, but need not detain us here, for, as a method of diagnosis, it is practically abandoned. If resorted to for this purpose, the surgeon should be prepared to follow it at once by ovariotomy, if he should obtain evidence to indicate an ovarian cyst. The early writers laid great stress upon its value, and even Sir Spencer Wells[1] and Prof. Thomas[2] speak approvingly of it as a means of diagnosis; but a careful reading of the latter author shows that he really means to describe it as a palliative mode of treatment, and among British ovariotomists neither Tait nor Keith, Thornton nor Bantock, employ it. Many years ago, Kiwisch proved that of 130 cases of first tapping of ovarian cysts, 17 per cent. were soon fatal; and the objections to this practice, unless the surgeon be prepared for an immediate resort to ovariotomy (as above stated), are too obvious to be discussed.

The *chemical* and *microscopical* characters of ovarian fluids have already been described in considering the morbid anatomy of these growths.

In doubtful and difficult cases, the *explorative incision* constitutes the final and crucial test of ovarian cysts. As in paracentesis, its danger is evident, and it must never be resorted to without making all the preparations for a completed ovariotomy. But it is more rational than tapping, and the wound inflicted is more directly under the surgeon's control.

A short incision—never more than two inches for a supposed cyst—is made in the linea alba, midway between the pubis and umbilicus. When the peritoneum is opened, the ascetic fluid, if any, is allowed to drain away, one or two fingers are passed into the cavity, and the surface of the growth and its connection with the pelvic organs are examined; the edges of the wound are then gently lifted, and the tumor is inspected by the eye, which at once distinguishes between the white glistening coat of a cystoma and the dark venous surface of an elastic soft fibroid. Finally, a sound or searcher is carefully swept around the surface of the growth in all directions, and its adhesions and probable origin thus ascertained. If doubt still remains, a careful aspiration of the tumor may be practised, the puncture being made with a fine hypodermic needle, and the fluid carefully inspected.

All this is done with antiseptic precautions, and with the utmost gentleness and delicacy, until a decision be reached to proceed with the extirpation of the growth. Should this be negatived, the wound is accurately closed with interrupted sutures (either silk or metallic) and dressed antiseptically, and the patient is placed carefully in bed, and for a week treated in all respects as if an ovariotomy had been performed.

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[1] Diseases of the Ovaries, p. 275.

[2] Op. cit., p. 716.

More or less peritonitis naturally results; but this is generally localized, and rarely dangerous; and experience demonstrates that the resulting conditions are less fraught with peril than those which follow the circular wound caused by an ordinary trocar.

Twice during the past year have I been compelled to resort to this proceeding; once in a case of extensive ascites from diffused papilloma of the peritoneum, complicated by a small sessile cyst in the iliac fossa; and once in a case of soft fibroma which was so elastic as closely to simulate the sense of fluctuation given by a cyst with thick walls. In neither case was the tumor removed; in the first, because it was only a minor complication, and would have left an extensive surface from which it would have been impossible to arrest the oozing of blood; in the second, because dense and extensive intestinal adhesions rendered hysterectomy (the tumor being inseparable from the womb) unjustifiable, while the patient's strength was only moderately impaired. Both patients recovered without a drawback, and have since enjoyed tolerable health.

I might cite similar cases which I have witnessed in the practice of others, were additional evidence necessary to illustrate the wisdom of resorting to explorative incisions.

Such are the numerous means by which an exact opinion may be reached in a case of supposed ovarian cyst, and the consideration of which brings us to the important question of differential diagnosis. Before entering upon this, it is well to restate briefly the chief signs of a typical cystoma, which are these: when the patient lies recumbent, the abdomen is protuberant and rounded, with little or no sagging at the flanks as in ascites; the sensation on deep pressure is firm and resisting; percussion is dull, especially on one side of the median line, while on the other it may be clearer; fluctuation is apparent, and, generally, quite distinct; a vaginal examination shows the womb to be movable and unconnected with the tumor; and both in the vagina and in the rectum the recognition of deep fluctuation is corroborated.

DIAGNOSIS.—In the differentiation of ovarian cysts, the following groups of disease or of complication have to be carefully considered and excluded:—

1. Morbid conditions of the abdominal walls.
2. Pregnancy, normal and abnormal.
3. Intra-abdominal disease, producing marked distention.

1. The first of these groups includes (1) œdema of the abdominal walls; (2) obesity; (3) phantom tumor, or tonic spasm; (4) spurious pregnancy.

(1) *Œdema of the abdominal walls* is characterized by deep pitting on pressure with the finger, and by uniform dulness on percussion; it is usually accompanied by œdema of the extremities and by the usual signs of renal or hepatic disease. Sometimes it coexists with an ovarian cyst, when deep fluctuation can always be detected.

(2) *Obesity* is often met with about the menopause, when, in many women, fat rapidly accumulates in the mesentery, omentum, or abdominal wall. Here the umbilicus is hollow and deeply depressed, and the thick layer of subcutaneous fat can be demonstrated by grasping it with the hand; or, when the deposit is intra-abdominal, a vague, tumor-like mass is felt, soft, rather doughy, gradually yielding to firm pressure, and never giving fluctuation on percussion.

(3) "*Phantom tumor*" is caused by persistent or tonic spasm of the recti muscles, and is commonly seen in hysterical women. Here percussion is resonant or nearly so, the "tumor" may be displaced by steady pressure while the patient's attention is diverted; but the crucial test is anæsthesia, under

which the abdominal swelling entirely disappears. In a few cases this curious condition is produced at will, but commonly the patient is quite innocent of deception, and the spasm is due to reflex spinal irritation.

(4) Cases of *spurious pregnancy*, so called, are generally met with about the menopause, although they may occur at any age. Here the condition is usually a mixture of the two last described. The patient imagines, or professes to imagine, herself pregnant, has morning sickness, enlargement of the breasts and abdomen, and sensations of quickening. On examination no tumor can be found; the uterus is normal in size and position, and the abdominal swelling is due either to fat, intestinal flatus, or phantom tumor.

2. True *pregnancy* has often been mistaken for ovarian tumor, and results disastrous alike to patient and surgeon have followed such unfortunate errors. I have seen in consultation two such cases—one of normal, one of extra-uterine (ventral) pregnancy—where ovariotomy had been advised; and Thomas[1] says that within eighteen months three were sent to him "not by ignorant men, but by very capable practitioners." In many cases indeed the diagnosis presents great difficulties; and, as the most usual form of abdominal enlargement in women, the possibility of pregnancy should always be borne in mind, and its existence carefully eliminated. This can only be done by reliance on its physical signs; the rational may be, and often are, concealed and falsified by the patient.

In *normal pregnancy* these are well known. For the first two months the womb remains in the pelvis, slowly enlarging and becoming softer, as conjoined examination easily demonstrates. The swelling is in the median line, while a small ovarian cyst is always lateral. In the third month the uterus rises to the pelvic brim, but presents no new physical signs until the fifth, when enough amniotic fluid collects to give rise to slight fluctuation. This continues until the full term is completed. Its quantity varies greatly in different cases; and where the accumulation is considerable and the uterine walls thin, the sense of fluctuation is quite distinct. But careful palpation always reveals the fœtus as a solid body floating in it. This ballottement, in conjunction with the typical softening of the cervix and blueness of the vagina, usually suffices to determine the diagnosis. The placental murmur is unimportant, as a similar sound is often obtained in soft fibroids, and occasionally in vascular cysts; but if the child be alive, the crucial test is the sound of the fœtal heart, which nothing simulates. The spontaneous movements of the fœtus, if distinct, are also conclusive of pregnancy; but these are often difficult to distinguish from muscular or intestinal contractions.

In *extra-uterine pregnancy* the differentiation is less easy. Of the three clinical varieties of this distressing anomaly—tubal, interstitial, and abdominal—only the first and last named need detain us; for interstitial pregnancy is not only excessively rare, but, forming as it does a tumor-like mass inseparable from the womb, it is unlikely to be mistaken for a cyst at any stage of development.

In *tubal pregnancy* the resemblance to a young cyst is extreme, and the diagnosis can only be made by careful attention to the accompanying symptoms. An intra-pelvic cyst is either discovered by accident, or pain—general, pelvic aching—alone leads the patient to apply for advice. It is far otherwise in tubal pregnancy. Here also pain occurs, but it is paroxysmal, confined to one iliac fossa, often intensely severe, and "bearing-down" in character like the lesser expulsive pains of labor or miscarriage; with this occur intermittent attacks of uterine hemorrhage, which at times is quite profuse and exhausting. Besides this, menstruation has ceased or has been irregular, and the gastric and mammary signs of pregnancy commonly exist. Physical examination shows the womb enlarged and soft, often displaced laterally, and a bulging tumor in one iliac fossa. This tumor is insensitive and soft, with a vague sense of fluctuation, occasionally yielding ballottement, almost immovable, easily separable from the uterus, and sometimes, but rarely, behind it, when the womb is pushed upward and forward by the new mass, instead of to one side. If an opportunity be presented for repeated examinations, the lateral mass will be found to increase rapidly in size, while all the foregoing symptoms are aggravated. When these signs are concurrent, the conclusion to which they point will be obvious to every reflective observer; in actual practice this rarely happens, but enough evidence is generally obtained to reach a correct diagnosis without much difficulty. The researches, in this field, of Parry, of Stephen Rogers, and more recently of Gaillard Thomas, have placed the American profession under lasting obligation to those writers.

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[1] Op. cit., p. 712.

In *ventral or abdominal pregnancy* the differentiation is, perhaps, more difficult; very much so, and almost impossible, in its early stages. But this is unimportant, as such cases are apt to be seen only when the fœtus is well advanced in development.

Here the outlines of the child can often be made out, and its spontaneous movements observed, through the abdominal wall, while the uterus is found to be softened and empty, and the patient's history is one of the concurrent symptoms of pregnancy. The sense of fluctuation is imperfect or wanting; never clear and unmistakable, as in well-marked cystoma. When the child is dead, and has been carried in its fœtal envelope for a long time, perhaps for years, no indication may be given of the true nature of the case, although the irregular outline of the fœtal mass, and occasional indications of septicæmia, may here aid in the diagnosis. When a suspicion of ventral pregnancy exists, explorative incision should not be lightly undertaken, and the constitutional state of the patient must form the only guide to operative interference. But in cases of commencing hectic, this affords the patient's only chance of life, and should never be postponed.

Besides the differentiation from pregnancy alone, the coincidence of pregnancy with an ovarian cyst must always be remembered, and its possible existence eliminated. From the fact that the enlarged uterus remains in front of the cyst, and is not affected by changes of position, this is sometimes extremely difficult. Pregnancy may be suspected when the vaginal examination shows the womb to be elevated, with the cervix high up behind the pubic symphysis, obscure fluctuation behind this point, and more abdominal distention than either mass alone seems to account for; or when the abdomen presents an uneven surface with some history of pregnancy. This applies to the early stages; as pregnancy advances, the usual tests, of course, render diagnosis more easy. The frequency of this complication is sufficiently shown by all writers on ovariotomy. In 1880, Sir Spencer Wells had operated in ten cases of this kind, with only one death; Mr. Tait has published an equal number of cases, all I believe successful; Schroeder, Olshausen, and Hegar, in Germany, Sims, Thomas, Homans, and others in this country, have all met with cases (I have published two from my own practice) in which the diagnosis was easily made beforehand. The works of Peaslee and Atlee may be consulted with profit for details of earlier cases.

3. *Abdominal enlargements* from other neoplasms or from structural changes of the abdominal viscera, require, however, by far the gravest consideration in the diagnosis of ovarian cysts. They are, also, the most frequent sources of confusion in this regard; for, although it has been stated that pregnancy is the most common source of abdominal enlargement in women, the surgeon

is required to diagnosticate it from a supposed cyst in only an infinitesimal ratio of cases.

But here a tumor or an enlargement from some morbid cause evidently exists. Is it a cyst? and, if a cyst, is it ovarian? These are the questions which must now be elucidated.

The diagnosis from *ascites* has already been indicated. Here the abdomen is more generally enlarged and less globular when the patient is recumbent; percussion is usually clear in front and dull in the flanks; change of posture at once alters the area of dulness; the superficial veins are not much distended; the umbilicus is protuberant; the womb is depressed or unaltered in position.

Fecal tumor gives a doughy feeling on deep pressure, may be indented, and, unless enormously developed, may be traced along the transverse or descending colon; percussion is dull, there is no semblance of fluctuation, and a history of chronic constipation may generally be obtained.

Uterine tumors are most frequently confounded with ovarian cysts by the general practitioner, and often form for the specialist the most difficult source of differentiation. But whether fibro-cyst, fibroma, sarcoma, or malignant tumor, the diagnosis can usually be reached by the following indications:—

In all uterine tumors the abdominal swelling affects the lower segment chiefly; the womb is more or less distinctly movable with the tumor; the growth of the mass is slow; menstruation is markedly affected and generally in the direction of metrorrhagia; fluctuation is never present, except in the case of fibro-cysts, when it is felt obscurely and in certain regions of the mass only. The elasticity of soft and rapidly growing fibromata is, by careless examiners, sometimes mistaken for fluctuation; but a distinct wave of fluid is essentially different from this.

For a more exact diagnosis, the differential signs may be stated successively as follows:—

(1) In *uterine fibro-cyst* the patient is generally at middle age, this form of tumor rarely, if ever, occurring under thirty. Her history shows that the growth has been slow, often ten or twelve years in duration. The general health has not rapidly declined, although distention may be great and more or less metrorrhagia may have existed. The tumor is large, more irregular in outline than an ordinary cyst, obscurely fluctuating above, and harder below. Vaginal examination shows the womb to be dragged upward, the cervix generally lying behind the symphysis pubis. If a sound can be passed, which is not always practicable, the depth of the womb will be found increased to three and a half or four inches; and rotation of the uterus on the sound will be felt in the tumor, or abdominal movement of the tumor will be distinctly communicated to the sound. Aspiration obtains a clear or straw-colored fluid which coagulates spontaneously, and may show under the microscope the so-called "fibre-cell," upon which Atlee and Drysdale have laid much stress. If the cyst be exhausted by aspiration, the top of the tumor collapses, while the lower part remains hard and semi-solid. Finally, as Hegar has advised, if the patient be etherized and the tumor rotated by an assistant, while the cervix uteri is drawn down with a tenaculum, careful rectal exploration will often reveal the connection of the tumor with the womb.

These are the indications of a uterine fibro-cyst, and they will often guide the surgeon aright; but, sad to say, as often they are fallible. Fifteen years ago I published the statistics of all the cases then to be found in English, French, and German literature: in nineteen of these cases laparotomy had been performed; in all but one under the supposition that the cyst was ovarian.[1] What was true then should not necessarily be true to-day; but the correctness of Sir Spencer Wells's declaration that, even after explorative incision, only a darker and more vascular look of the surface is indicative of a fibro-cyst, has never yet been disputed.

(2) *Fibroma*, or *uterine fibroid*, can only be mistaken for a cystoma when much ascites complicates the case, or when the abdominal walls are unusually thick. Ordinarily the *subperitoneal fibroma* (which alone need concern us) is lobular or of irregular outline, of stony hardness, often multiple, so that distinct lumpy masses can be felt in the lower abdomen, and inseparable from the uterus which moves with it. The growth is slow in formation, never causes progressive emaciation or affects the general health except by its pressure or the metrorrhagia which it may excite, and is rarely painful or tender. Uterine exploration shows the cavity to be deeper than usual, sometimes tortuous or deflected, and the womb to be pushed down or to one side. The lower pelvis is often filled by the lobular masses of the tumor, and the rectum or bladder is much compressed. Usually the growth is sessile, a voluminous outgrowth from the sides or fundus of the womb; but in rare cases it is pedunculated. Some years ago Dr. Hunter, my colleague at the New York State Woman's Hospital, removed a large uterine fibroid under the supposition that it was ovarian. It was freely movable, and was attached to the uterus only by a long and slender pedicle which was easily ligated.

(3) *Sarcoma of the womb* is rarely as distinct an outgrowth as fibroma. Generally developing in the uterine cavity, it causes distention only by symmetrical enlargement of the womb. In the exceptional cases where outgrowths occur into the pelvic or abdominal cavity, these can only be inferentially distinguished from fibromata by their greater softness and the cachectic condition of the patient. In the former case the uterine sound, in the latter the absence of fluctuation and the peculiar impairment of health characteristic of malignant disease (and without much emaciation), will guide us in the diagnosis.

(4) *Carcinoma of the uterine body* is often indistinguishable from sarcoma, except in the more rapid course which it runs. With cancer of the cervix we are not concerned; and whether it affect the neck or the cavity of the womb, it is as Dr. Henry Bennet long since pointed out, only after ulceration begins, that the patient applies for advice. Then hemorrhage, and foul watery, or ichorous, discharges from the vagina, indicate too clearly the nature of the disease; and, as has well been said, make the diagnosis as obvious as before it was unsuspected. Only when it involves the fundus or the upper uterine walls, then, is cancer likely to be mistaken for a cystoma. Here proliferating masses are often thrown out in the pelvis, contiguous organs are soon involved, and attachments rapidly form with the intestines, peritoneum, and omentum, until the entire contents of the lower abdomen become amalgamated into a tumor-like mass with irregular outline and much accompanying ascites. With care, however, an accurate diagnosis can usually be made. The hard, nodulated, and irregular surface, the absence of fluctuation in the tumor while obscure fluctuation is often obtained around it, the greater degree of pain and aching in the growth, and, above all, its rapidity of development and the corresponding impairment of the patient's health, with fixation of the uterus, or its restricted mobility with the abdominal mass, are all indicative of this type of malignant disease.

Cystic disease of other organs sometimes proves a source of great embarrassment to the diagnostician, and requires brief consideration. Thus renal, splenic, and hepatic cysts, cysts of the broad ligament and of the omentum, have all been subjected to laparotomy in mistake for ovarian disease. The three former varieties may be distinguished by the fact that they grow from above downwards, that fluctuation is most marked above, with an area of dulness below, and that vaginal touch and rectal examination by Simon's method show the pelvic organs to be intact and disconnected from the tumor. In each, moreover, the viscus involved—kidney, spleen, liver—will usually give some constitutional evidence of its disease; in renal cysts the fluctuation can generally be traced directly back into the flank, and in splenic, no amount of deep palpation will reveal the serrated edge of the organ. For greater thoroughness, the examination should be made under ether in these obscure cases; but sometimes they baffle every test but explorative incision, which should always be held in reserve.

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[1] New York Med. Journal, Nov. 1871.

Last year, a middle-aged woman was sent from Virginia to Dr. Emmet, who transferred her to his service in the Woman's Hospital for ovariotomy. The tumor proving doubtful in character, Dr. Thomas and myself were asked to see her in consultation, and, after a most careful examination, each decided (separately and without knowledge of the other's opinion), that the tumor was a well-marked splenic cyst. As the patient's health was not much broken, Dr. Emmet felt disinclined to subject her to the risk of probable extirpation of the spleen, although both his colleagues thought that it could be surely accomplished; and her husband, becoming alarmed at the opinions given, took her home without operation. A few months after this she became more ill, developed peritonitis, and died. I am informed that at the autopsy, the cyst was found to be ovarian, with a long and thin pedicle, "and entirely free from adhesions of any kind." The latter statement seems incredible, as it was impracticable to separate the spleen and tumor when the examination was made; but the lesson taught by such a case is self-evident.

Usually *renal cysts* are more difficult of detection than either splenic or hepatic, from the fact that they are more apt to assume a central position in the abdomen; and if careful aspiration and Simon's method of rectal exploration fail to demonstrate their character, an explorative incision should always be made. In many cases they have been safely removed by laparotomy.

Cysts of the broad ligament have already been referred to, and are of much less importance in differential diagnosis, as they affect health less, and are more easy of cure, either by aspiration or by laparotomy. While it is practically impossible to distinguish them with certainty, their presence may usually be inferred from the existence of lighter and more superficial fluctuation, slower growth, less impairment of the patient's health, a clearer and more limpid fluid on aspiration, complete subsidence and (often) permanent disappearance of the cyst after tapping, and a whiter and more glistening appearance of the cyst-wall on abdominal section.

Encysted abdominal dropsy, which was not referred to under the head of ascites, is usually due to slow inflammatory processes which leave sheaths or bands of enveloping lymph, within which large quantities of fluid may be collected. Obscurity here is due mainly to the fact that the intestines cannot rise above the fluid, as in ascites, and that change of posture does not affect the area of fluctuation. Aspiration, with careful analysis of the obtained fluid, examination by the rectum and vagina, and, lastly, an explorative incision, are the only means of diagnosis which we possess.

PROGNOSIS.—Only the most discouraging prognosis can ever be given of ovarian cysts. Cases are recorded in which they are said to have undergone a retrograde change and to have disappeared spontaneously; but it is notable that such reports, though frequent enough twenty or thirty years ago, are now rarely heard of. In all likelihood the tumors in these cases were ligamentous cysts, whose accidental rupture was followed by absorption of the fluid and collapse of the sac.

While the cyst remains intrapelvic, it is cause for anxiety only; the moment it enters the abdominal cavity it becomes a source of increasing danger to health and ultimately to life; while, after much distention has begun, a fatal issue is only a question of time. Broadly, it may be said that the average expectation of life at this period is from two to five years, and that polycystic tumors are more rapidly fatal than monocysts.

TREATMENT.—The medical treatment of ovarian cystoma is palliative only, and consists entirely in attention to the general health, in enforcing regularity of meals, in the selection of proper food, and in the administration of tonics. The curative measures are surgical, of which paracentesis has already been discussed, while the radical procedure of ovariotomy is yet to be described.

Before this, however, it is advisable to present a brief sketch of certain ovarian neoplasms which, though less frequent than cystomata, are yet of the gravest importance.

II. DERMOID CYSTS OF THE OVARY.

Dermoid cysts, so called by Lebert from their containing skin or tissues resembling skin, may occur in any part of the body, but are most frequently found in the ovary. Their origin was long a stumbling-block to pathologists, but it is now known they are always congenital, and due to a displacement of the layers of the blastoderm in embryonic life. From the external layer of this tissue "the epidermis and other structures are developed; and it is supposed that a portion of it becomes included in the part of the middle layer from which the ovary is formed, and thus forms the rudiments of cysts of a dermoid character." (Williams.) These growths generally remain dormant until puberty, and then develop with some rapidity until they reach the size of an orange or the fœtal head; after that their increase is extremely slow. They have, however, been found at all ages of infancy. Cases are recorded by Kiwisch, and by M. Pigné (quoted by Thomas[1]) in which they were found at all periods from birth until twelve years of age; they have been successfully removed by ovariotomy during childhood by Dr. Mears,[2] of Philadelphia, at six years and a half; and by Sir Spencer Wells[3] in a girl of eight years. The cyst-wall is composed of two layers: an external fibrous coat, and an internal layer which consists of true skin faced with epithelium. A stratum of fat often separates the two. The internal layer is smooth, but embossed here and there with prominences. The multiple contents are thick fluid, and greasy sebaceous matter, intermixed with laminæ of bone, more or less perfect teeth, and balls or locks of hair; sometimes muscular fibres and nerve-filaments.

The *symptoms of dermoid cysts* are analogous to those of true cystomata, but the fluctuation is less marked. A firm, round, smooth mass is felt in one iliac fossa, and is painless, movable, and separable from the womb, gives a faint sensation of fluid contents, and does not seriously affect the general health. Vaginal and rectal exploration proves this to be ovarian in its origin. The tumor is almost always single.

The *prognosis* is more favorable than that of ordinary cystomata at an early stage; at a later period they become a source of marked local irritation, and often display a tendency to suppurate.

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[1] Op. cit., p. 679.

[2] Philadelphia Med. Times, Nov. 1871.

[3] Obstetrical Journal of Great Britain and Ireland, April, 1874.

The only *treatment* is by laparotomy.

III. Hydatids of the Ovary.

Hydatids are so rare in the ovary as to be clinically unimportant, though they have been found both in this organ and in the womb. The diagnosis will depend on the character of the fluid, which may be clear or turbid, but under the microscope contains "hooklets" from the young echinococci, or particles of the "cuticular" or sac membranes.[1] Chadwick[2] has shown that they are not affected by acetic acid; and uric acid and urea have been found by Boldini[3] in echinococci.

IV. Solid Tumors of the Ovary.

Fibromata.—Fibroid tumor of the ovary is rare, but is met with often enough to deserve careful description. More frequently a large uterine fibroid is mistaken for it; and this is always possible when even a short pedicle exists, and the ovary on one side has become so amalgamated with the enlarging growth that it cannot be separately felt. Mention has already been made of a case in which my colleague, Dr. Hunter, removed an uterine fibroma with long pedicle, under the supposition that it was ovarian; and I have once seen an explorative incision made (and the laparotomy abandoned) in a similar case.

True ovarian fibroids are developed from the stroma of the ovary, and consist mainly of fibrous tissue; in a few cases, muscular fibre-cells have been found in them. In all respects they are analogous to uterine fibromata, except in their origin. Their size varies from that of an egg to that of a man's head, rarely if ever larger; for, although Simpson, Schroeder, and Spiegelberg, all describe immense tumors of this kind, Virchow and Bantock think them to have been cysto-sarcomata, and Thomas[4] shares this opinion.

The *symptoms* of these growths may be inferred from what has just been said. A hard, solid mass is felt in one iliac region. Careful palpation shows this to be smooth, movable, and independent of the womb; menstruation is not much interfered with, for the other ovary performs its function as usual, and the patient's health not at all, except in the minor way of local pressure. Fluctuation is absent; and when the rectum is explored by Simon's method, no trace of an ovary can be found on the affected side. These symptoms, again, indicate the diagnosis. From cysts, these tumors will be known by the absence of fluctuation; from uterine fibroids, by the separate mobility of the womb; from carcinomata, by their smoothness of surface and by the absence of constitutional taint. The prognosis is favorable as to life, as the only injury which they cause is by pressure on the surrounding organs.

The *treatment* is extirpation by laparotomy, if the discomforts and impairment of health resulting from pressure, or from the mental anxiety of the patient, necessitate radical action. Otherwise abdominal section should not be advised; and the treatment should be limited to palliation of the less serious symptoms as they are developed.

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[1] Garrigues, Diagnosis of Ovarian Cysts, etc., p. 74. 1882.

[2] Amer. Journal of Obstet., Feb. 1875.

[3] Centralblatt f. Gyn., Bd. ii. S. 512. 1878.

[4] Op cit., p. 676.

True sarcoma—spindle-celled sarcoma—of the ovary, is yet more rare than pure fibroma; and, when it occurs, its existence can only be inferred from the more spongy feeling of the tumor, its rapidity of growth, the tenderness on pressure, and the early impairment of the patient's health. Otherwise its symptoms and diagnosis are the same as those of fibroma; but the treatment, when once a diagnosis is reached, should always be extirpation by laparotomy. It may affect both sides simultaneously, and is often accompanied by ascites.

Carcinoma of the ovary is also exceedingly rare as a primary affection, but quite often it occurs as a secondary deposit.

All the recognized forms of cancer have been found in these organs, but the encephaloid variety is perhaps the most frequent. It has been met with in all ages, even before puberty, and is, perhaps, more common in early than in advanced life. It often attacks both ovaries. Whatever its form, it may affect the ovary in two different ways: either as diffuse infiltration of the stroma, when the whole ovary seems changed into a cancerous mass covered by free peritoneum, or, less often, as cancerous nodules growing in healthy ovarian tissue. In the latter case, two or three such small nodules will appear in the stroma, grow rapidly, and soon overwhelm the healthy stroma around them, and in this manner gradually turn the whole ovary into a nodular tumor. The starting point of cancer is always in the epithelial elements of the ovary.

Besides these, mixed forms of cancer and true cystoma, or *cysto-carcinoma*, also occur, and have been described by Schroeder, Wagner, Spiegelberg, and many others. In all its varieties ovarian carcinoma grows rapidly and tends to invade neighboring structures; either bursting through the envelope of the ovary into the abdominal cavity, or penetrating through the pedicle into the pelvic connective tissue. It irritates and inflames the peritoneum, provokes ascites, quickly sets up adhesions among the pelvic organs and intestines, and soon produces an immovable and complex mass in which the ovary is quite lost.

The *symptoms* of this distressing disease are, in the beginning, only those of other solid tumors; afterwards, rapid increase of the tumor, successive implication of both ovaries, ascites, œdema of the pudenda or lower extremities, pain of a more or less lancinating character, marked depreciation of general health and spanæmia, with chronic peritonitis, all combine to indicate this most hopeless form of pelvic disease.

The *prognosis* is obviously unfavorable. Death generally ensues from intestinal obstruction or from chronic peritonitis.

The *treatment* is palliative. Early recognition of the malady, which is most difficult, will justify ovariotomy. Unhappily, when the diagnosis is clear, the disease has passed beyond the point at which extirpation is possible; and attention to the general health, with the use of tonics, stimulants, and anodynes, constitutes all our resources towards making the patient's existence less pitiful than it would be without them.

It has been said that examples of the unmixed types of these solid ovarian growths are extremely rare. This is true. But the practitioner will often meet with cases of *cysto-fibroma*, *cysto-sarcoma*, or *cysto-carcinoma* of the ovary, where the merging of one type of neoplasm into the other, or the degeneration of a cystoma into semi-malignant disease, assumes every grade of variety. These tumors grow with rapidity, and at times attain an enormous size. They explain the accounts by early observers of immense growths of fibroma or sarcoma of the ovary, which are now known not to exist. They are very fatal, either with or without ovariotomy.

UTERINE TUMORS.

Leaving now the subject of ovarian growths, and before describing the surgical treatment for their relief, a brief outline will be given of such tumors of the uterus as are frequently met with in practice.

These may be conveniently divided into:—

I. Fibro-myomata, or uterine fibroids.
II. Uterine fibro-cysts.
III. Sarcomata.
IV. Carcinomata.

I. UTERINE FIBROIDS again are divided, clinically, into (1) submucous, (2) interstitial, and (3) subperitoneal uterine fibroids, which, although identical in their histological formation, produce different groups of symptoms, and require entirely different treatment.

Under the different synonyms of *fibroma*, *fibrous tumor*, *myoma*, *myo-fibroma*, *fibroid tumor* of the womb, is meant a growth, extremely frequent in occurrence, developed from or within the parenchyma of the uterus, essentially homologous with it, and consisting of mixed fibrous and muscular tissue. As the former of these elements is always in excess, the term "fibroma," or fibroid tumor, is evidently more correct than "myoma," as proposed by Virchow, and will be retained in this description.

Whatever form the growth ultimately assumes, every uterine fibroid is originally interstitial; accidental development determines its remaining in this condition, or becoming submucous, or subperitoneal.

In many cases it remains permanently enmeshed within the uterine wall, producing general and excessive hypertrophy of the neighboring parenchyma, persisting congestion of the womb, which nature tries to relieve by metrorrhagic flows, and displacement of the uterus toward the side on which its development has occurred.

If by degrees it projects into the cavity, the more yielding mucous membrane offers no barrier to its progress; and it either remains sessile, or becomes pedunculated from constriction of its base, and constitutes the so-called *fibrous polypus* of the womb, which is somewhat rare.

The subperitoneal or subserous variety of fibroma, is determined by similar causes; here the process of growth is eccentric, because either the external layers of uterine tissue are thinner and more yielding, or because accidental congestions of the uterine surface supply the incentive to development.

Fibromata are by far the most common of all uterine tumors. Klob estimates them as present in 40 per cent. of women who die after middle age—doubtless an excessive estimate. Their greatest frequency is during middle life: Schroeder says between forty and fifty years of age; Gusserow, of Stuttgart, between thirty and forty; Emmet between thirty and thirty-five. As to the influence of sexual activity these authors differ, Gusserow reporting 673 in married women out of a total of 959 cases; while Emmet, whose tables contain most elaborate analyses, infers from a total of 225 cases that the unmarried is twice as liable as the married woman to develop fibromata; Hart and Barbour, following Gusserow, take directly the opposite ground.

The unquestioned coincidence of sterility, whether as cause or effect, may possibly explain the difference of opinion.

LOCATION AND STRUCTURE.—The *location* of fibromata is, in the vast majority of cases, in the body of the womb, rarely in the cervix; and in the body they occur most often in the posterior wall, less frequently in the anterior wall, and still more rarely at the sides. Often multiple, they occur sometimes in extraordinary numbers: Dr. Thomas quotes a case in which thirty-five such tumors were found in the uterus, Schultze has seen fifty, and in a fatal case of placenta prævia published[1] by myself, at least twenty fibromata were found in the uterus, and had prevented its efficient contraction.

In *structure* all such growths partake of the same elements as their parent tissue, the uterine wall, and contain pure fibrous tissue and unstriped muscular fibre, as above stated. They vary greatly as to the proportion of these constituents, from the pure myoma, which is soft, rapid in growth, so as sometimes to attain enormous proportions, and happily rare, to the almost pure fibroma, which shows a white, glistening surface on section, is developed very slowly, and is almost cartilaginous in hardness.

In the common mixed tumor (or fibroid tumor proper), the fibrous element predominates, and is developed in concentric layers or bundles, separated by sparse supplies of muscular fibre, or by interspaces which Klebs thinks lymphatic spaces. This is surrounded and enveloped by a "capsule" of loose fibrous tissue. A few bloodvessels and nerves have also been traced into the structure of these growths.

The immediate neighborhood of the tumor is in a constant state of congestion; and, as development progresses, the neoplasm advances from the uterine surface with varying degrees of rapidity, until it may fill the uterine cavity, or, when subserous, until it gradually fills the entire cavity of the abdomen. Accident determines its remaining sessile, or becoming pedunculated. In the latter case, the submucous growth may gradually become elongated and form a *fibrous polypus*, and, exciting uterine contraction, may be gradually extruded into the vagina; or, if subperitoneal, it may gradually be separated from the uterus by an elongating pedicle, and may finally be detached entirely from its surface. As it ascends into the abdomen, it may draw the uterus upwards, elongating its cavity and, according to Virchow, even tearing the body of the womb from the cervix by steady and gradual traction. Subperitoneal fibroids with long pedicles are peculiarly liable to complicate the patient's health by their mobility, by their tendency to sink by gravitation into the pelvis and there become incarcerated, and by their liability to sphacelation or gangrene from twisting of their pedicles. Fatal cases of this accident, in which death has ensued from septicæmia or septic peritonitis, are occasionally reported, and certainly occur more frequently than is commonly supposed.

Degenerative Changes.—The *degenerative changes* which fibroids undergo are induration with occasional calcification; softening with œdema or fatty degeneration; and, more rarely, cystic, or true malignant degeneration. The first of these generally occurs at or after the menopause, and is always a condition of retrograde metamorphosis. Freund and Martin (quoted by Gusserow) report cases in which true fatty degeneration has occurred at the same epoch; and œdematous alterations are well known to many observers. Cystic degeneration and malignant degeneration, whether sarcomatous or carcinomatous, are more rare; but modern research leaves no doubt that all true fibro-cystic tumors of the womb originate in this way.

Klebs, Winckel, and Virchow have all written elaborately on the *etiology* of uterine fibroids; but it remains as true to-day as it was when Gusserow said it ten years ago: we know as little of the causation of these growths as of that of most other neoplasms—"nämlich *nichts*." It is therefore a waste of time to repeat the hypotheses that interested a former generation of readers, and we may pass at once to the symptoms, diagnosis, and treatment of these tumors.

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[1] Trans. of New York Obstet. Soc., vol. i.

SYMPTOMS.—The subjective symptoms of fibromata may often remain latent for years, until either the slowly growing tumor increases so as to compress other organs, if subserous, or to excite uterine hemorrhage if submucous, or until increased sexual activity leads it to provoke menorrhagia and dysmenorrhœa, when interstitial. For this reason, as already mentioned, it is exceedingly difficult to fix the date of origin of these growths, and all statements of their frequency in married or single life must be taken as approximative only.

When this degree of development has been reached, the resulting symptoms may be grouped as follows: (1) Hemorrhage: menorrhagia, metrorrhagia; (2) Dysmenorrhœa; (3) Dragging pain and discomfort in pelvis; (4) Pressure on contiguous organs; (5) Sterility or abortion.

Of these symptoms *hemorrhage* undoubtedly ranks first, both in frequency and importance. Usually this is an aggravation, more or less marked, of the menstrual flow, rather than an intercurrent bleeding; rarely, if ever, in the early stage, is it sudden like the unexpected hemorrhage of carcinoma. All forms of fibroma add to the tendency to menorrhagia; but large or multiple inter-mural growths are those most sure to produce it, while submucous tumors and polypi lead to irregular (or metrorrhagic) hemorrhagic flows, and subserous tumors are least active in this direction. When the latter are found without any antecedent history of hemorrhage, they have probably been pedunculated from the outset. Naturally such growths have very little uterine influence. When menorrhagia alone occurs, the source of the hemorrhage is the generally engorged endometrium; in metrorrhagic flows, according to Hart and Barbour, "ulceration of the mucous membrane covering the tumor, or rupture of the dilated veins in its capsule," is the cause of the bleeding, which may be sudden, frequently recurrent, and alarmingly copious. Cases have been reported by Cruveilhier, Matthews Duncan, and the late Dr. Peaslee, of New York, in which death rapidly followed these enormous losses of blood. The hemorrhage seldom comes from the mucous membrane covering the growth, when it is tense and atrophied, or from the tumor, which has but little vascularity. When the growth has assumed a polypoid condition, the irritation caused by its presence, and the frequent uterine contractions which it excites, lead to a constant leucorrhœal discharge, which is tinged with blood and almost pathognomonic of this condition. Unlike the drainage from uterine cancer, it is neither watery nor fetid in odor.

Dysmenorrhœa often accompanies fibroids of the submucous form, either before or after their polypoid development. This is due to the temporary engorgement of the tumor and its envelopes, which increases its tendency to pressure, and often induces uterine contractions. In cases of interstitial and subperitoneal growths, some writers have described a *dragging pain* distinct from this, and due (as Gusserow supposed) to the filling of the tumor with blood; but this is a rare exception to the general rule that intra-uterine fibroids cause dysmenorrhœa, while inter-mural and extra-uterine growths do not.

Pressure on the neighboring organs may affect either the bladder, rectum, ovaries, or pelvic bloodvessels; and in the case of very large tumors, all of these at once, and the upper abdominal viscera in addition. Often the rectal or vesical tenesmus, or the varicose veins, thus caused, will first induce the patient to seek advice, and thus lead to the detection of the tumor. If incarcerated in the pelvis, complete intestinal obstruction may occur and necessitate colotomy; and more than one fatal result has thus been recorded. Compression of the kidneys and ureters, with fatal uræmic symptoms, has also been observed; but in such cases extensive adhesions have existed, and have limited the growth of the tumors in one direction.[1]

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[1] Hüc, Annales de Gyn., t. iv., p. 239; Gusserow, in Billroth's Handbuch.

Sterility and *abortion* are both, under different conditions, attributable to fibromata. Pregnancy, indeed, very rarely occurs where a submucous or interstitial fibroid has attained any degree of development. Schroeder attributes this to the diminution of the cavity of the womb; in one hundred and forty-nine cases in married women, he found that in more than thirty-three per cent. the patients were sterile, while in the remainder only a very small number of children had been born. Emmet's experience has been similar to this, and the ratio of sterility which he gives is still higher. Where conception happens to occur, early abortion or miscarriage is likely to follow from the uterine irritation above described; and, should pregnancy continue to full term, labor is almost sure to be complicated by the presence of a large growth:—

In the American Journal of Obstetrics for January, 1886, is a well-reported case by Dr. C. A. Kirkley, of Toledo, Ohio, in which an unsuspected submucous fibroid in a primipara impeded the descent of the fœtus; as a last resort craniotomy was employed, and even then the child was removed with the utmost difficulty. After this a large sessile fibroma was found projecting from the anterior wall, filling nearly one-third of the uterine cavity, and tightly wedging the child's body against the uterine walls. The patient died in twenty-four hours. In this and in similar cases, as the author remarks, the Cæsarean operation (or even Porro's) would have given a better chance of survival, had the complication been known beforehand.

Physical Signs.—These, of course, differ in the three several groups of fibromata above referred to. The *submucous fibroid*, if pedunculated, and if in the lower segment of the womb, can readily be felt with the finger, as a firm, round, or elongated mass projecting from the uterine wall. If above the internal os, the cervical canal must be dilated before this can be done. When sessile, the lumpy fulness and projection of the uterine wall which it causes may, perhaps, be mistaken for uterine displacement. The direction of the uterine sound, and bimanual palpation, will serve to exclude this source of error; and, by the careful use of a flexible (whalebone) sound, as suggested by Thomas, the outline of the growth may almost always be determined.

Interstitial fibroids in the lower segment of the womb are difficult of diagnosis; they cause bulging and distortion of the lip of the cervix, and thickening and localized hardness or induration of the uterine wall, while by rectal examination the womb is found to be not displaced. When higher up, the sound is invaluable as an aid in diagnosis; after it is gently passed, the womb is made to impinge against the examining finger in the *fornix vaginæ*, and afterwards in the rectum. If there be a fibroma of appreciable size, the finger will soon detect the globular thickening and peculiar sense of *density* which the healthy uterine wall never yields. Here too the direction of the sound saves us from mistaking an anteflexed or retroflexed uterus with thickened fundus, for a tumor.

Still, it will always remain true that small interstitial, or subserous, fibroids are extremely difficult of detection; and that, when complicated by inflammatory deposits, their certain diagnosis is impossible.

When large, *subperitoneal fibromata* are almost unmistakable. They are hard, solid, with well-defined outline, dull on percussion, intimately connected with the womb and moving with it, and present the "uterine souffle" on auscultation. By vaginal touch, the tumor, if pelvic, is felt to be hard, nodular, often multiple, and inseparable from the womb, which is generally pushed or dragged high up, so that the cervix lies behind the symphysis pubis; the cervix is also indurated, and the uterine cavity elongated.

Diagnosis.—Uterine fibroids are most apt to be mistaken, when small, for anteflexion or retroflexion of the womb, for early pregnancy, or for the results of perimetritis or pelvic hæmatocele; when large, for ovarian tumors, for late pregnancy, either normal or extra-uterine, for fecal impaction, and for hæmatocele. With care, however, their differentiation from most of these conditions should be easy. In uterine *flexions*, the sound and bimanual palpation will always reveal the state of the womb. In *early pregnancy*, that organ is soft and compressible, and usually the concomitant symptoms of gestation are present: in the case of fibroma the latter are absent, and the cervix and upper uterus are even harder than usual. In *perimetritis* the pelvic tissues are boggy to the touch, and there is no definite outline of a tumor. In *hæmatocele*, whether large or small, the history of the attack and the peculiar physical signs, which are at first those of a soft, fluctuating tumor, and afterwards those of a boggy, indurated mass, will guide us aright. The uterine position may here be altered, but its consistence will be unaffected, and there will be no induration of the cervix.

Ovarian tumors[1] are comparatively soft and elastic; they fluctuate on percussion, yield no uterine souffle, and are usually not movable with the uterus. In its later stages *normal pregnancy* is easier of differentiation than at an earlier period; for, in addition to the signs specified, we have then the aid of ballottement, of the fœtal movements, and of uterine contractions, and the signs of the fœtal heart to guide us aright. But, if the fœtus be dead or if the pregnancy be *extra-uterine*, the difficulty of diagnosis is much greater. Here the history of the case, which in fibromata will be one of slow growth and frequent flooding, and the fact that the tumor is firm and unyielding, is of great assistance; in abdominal pregnancy the gestation sac grows rapidly, while the uterus is of normal size and depth, and its mobility independent of the abdominal growth. *Fecal impaction* is distinguished by the facts that the tumor pits on deep pressure, and that it exerts little or no influence on uterine health, but much upon the patient's digestion and habits of defecation.

Prognosis.—In considering the prognosis of fibromata, extreme caution should be exercised before a final opinion is given; and the natural course of the disease, the exact variety and nature of the tumor, and the prominent symptoms present, should all be taken into account. Death occurs with extreme rarity as the direct result of the disease, although, as above noted, cases have occasionally been reported as fatal from sloughing of the tumor and septicæmia, from simple peritonitis due to pressure, from hemorrhage from the sac, and from uræmia caused by renal pressure.

On the other hand, the disease sometimes undergoes spontaneous cure; this occurs relatively at the menopause, and absolutely from a variety of causes narrated in the cases which Schroeder[2] has laboriously collected. This author gives the literature of thirty-six cases (Gusserow, after sifting them carefully, reduces the number to thirty) in which a complete cure, with disappearance of the growth, took place. In one of these cases, in which eight fibroids existed, Madge[3] says that several disappeared within a short time after labor, and that others diminished in size. In another case, not included in this list, Emmet[4] reports that a large and pronounced subperitoneal fibroid disappeared during pregnancy, and that after the patient's confinement her attendant could find no trace of it. With the details of this case I am myself personally familiar. Still others have been reported by Prof. A. R. Simpson.

Besides this process of retrograde metamorphosis and absorption, a perfect cure sometimes occurs through *spontaneous expulsion*. This may take place through the breaking down of the tumor, which is always a critical affair for the patient, since it involves risks of fresh hemorrhage and septic absorption; through ulceration of the capsule and gradual enucleation of the growth; and through extrusion of the tumor, if pedunculated, into the vagina or rectum. Spontaneous enucleation is exceedingly rare; pedunculation and extrusion of the tumor into the vagina are quite commonly met with.

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[1] See page 795, *supra*.

[2] Ziemssen's Cyclopædia, Am. ed., vol. x. p. 242.

[3] Trans. Lond. Obstet. Soc., vol. xiv. p. 227.

[4] Princ. and Pract. of Gynæcology, p. 544. 1884.

Treatment.—This may be either dietetic, medical, or surgical. In the matter of diet, it has been found by Cutter[1] that farinaceous food and milk contribute to the growth of fibromata; while a strict regimen of meat and wine, or with the slight modifications allowed in diabetic diet-lists, will in many cases diminish their volume. My own experience in a limited number of cases has confirmed this statement; but the enforcement of such a regimen is not always successful or even practicable; and, if adopted, it should be combined with a careful employment of medical treatment also.

Here there is only one drug—*ergot*—which at all deserves our confidence; and, instead of acting directly upon the tumor, its influence is chiefly through the unstriped muscular tissue of the womb.[2] It is best used hypodermically in the form of Hildebrandt's or Merck's ergotine, of which from three to ten grains, dissolved in water, or in water and glycerine, may be injected every second or third day. To this solution chloral has been added to make it keep better; but in any case it soon decomposes, or becomes inert, and should often be made up afresh. Hildebrandt's injections were made in the hypogastrium, but the hip is now generally preferred, and if the fluid be thrown deep into the gluteal muscle, or the thick subcutaneous tissue, neither abscess nor erysipelatous inflammation need be feared. This mode of treatment must be continued for several months; and, just before each menstruation, the injections should be increased in frequency and thoroughness. When given otherwise than hypodermically—in pill, fluid extract, or suppository—ergot is indecisive, and usually disappoints our expectations.

In conjunction with rigid diet, Dr. Ephraim Cutter, of Boston, used the galvanic current, which was passed into the tumor through strong steel needle-electrodes; and in 1880 he reported to the Boston Gynæcological Society a series of 50 cases, in which 4 patients had been quite cured, 32 improved, and 4 had died through this treatment. In five cases of subperitoneal fibroid—all in private practice—in which I have instituted this treatment, not one has seemed to be benefited by the electrolysis. In another case in the care of one of my colleagues, at the Woman's Hospital, hysterectomy has just been performed, after repeated and painstaking efforts to remove a multiple subserous fibroid by electricity. In the future it may, perhaps, be differently applied with better results.

The *surgical treatment* of fibromata naturally divides itself into procedures for the removal of the tumor through the vagina or through the abdominal walls.

Leaving the subject of laparotomy, including hysterectomy, for future consideration, the first of these methods will now be described.

This is multiple, and consists of, (1) Avulsion; (2) Écrasement; (3) Enucleation; (4) Gradual traction by Emmet's method.

Avulsion is effected by steady and forcible traction with forceps or stout tenacula, which sometimes tear loose the attachments of a sessile tumor or break the pedicle of a polypus. If the uterine attachments should not yield, two fingers are, if possible, passed into the womb, and separation aided by them. This plan of treatment is now practically abandoned, and twenty years ago was condemned by West as a relic of barbarous surgery.

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[1] Amer. Journ. of Obstetrics, October, 1877.

[2] Hence it is least applicable to subperitoneal fibroids.

Écrasement is most applicable to the removal of polypi and of pedunculated fibroids. It may be practised either with the chain-écraseur of Chassaignac, the wire-écraseurs of Simpson or Braxton Hicks, or the galvano-cautery wire. In either case the object is the same: to remove the tumor more slowly and with less hemorrhage than with knife or scissors. In this mode of treatment the patient is etherized and placed on her left side, and the tumor or cervix is exposed with Sims's speculum; if the growth is still intra-uterine, the cervix is cut or dilated until the tumor is reached; this is then drawn down with volsella, or with lion-toothed or Museux's forceps, and the chain or wire is carefully passed around the pedicle; just before the chain or wire is tightened, additional traction is made on the tumor to be sure that as much of the pedicle as possible is included in the loop. Then the screw is worked, or the galvanic current is turned on, *very slowly*, so as to heat the wire only to a red heat, or to crush the pedicle only after gradual strangulation. Little or no hemorrhage should attend this step of the operation; if the tumor be too large to pass the vulva, it should be cut up and removed piecemeal. Écrasement is preferable to the old method of excision; but, except with the galvano-cautery, it is little practised in this country.

Enucleation is adapted to the removal of interstitial fibroids and of such submucous growths as still retain a sessile base. It may be accomplished (1) by incision of the mucous membrane covering the face of the tumor, and then leaving its gradual expulsion to nature with such aid as ergot can give to the uterine contractions; (2) by detaching the tumor from its capsule by Emmet's or Simpson's nail-curette, by Sims's enucleator, or by Thomas's spoon-saw. By whatever method practised, enucleation is always fraught with danger to the patient, while to the most expert surgeon it is more difficult than ovariotomy. It should never therefore be attempted until all means of palliating the disease have been exhausted.

Its steps are as follows: The patient is etherized and kept in Sims's position on the left side. The cervix (previously dilated) is caught up with a stout tenaculum and divided bilaterally with scissors or thermo-cautery; preferably with the latter. The tumor is now examined with the finger, and its attachments to the uterus (previously examined with a flexible sound) are accurately determined. A deep incision is made through its mucous membrane and capsule at the most convenient point, a strong volsella or lock-forceps is buried in the neoplasm, and, while moderate traction is made, the enucleator or spoon-saw is inserted between the stretched tumor and capsule, and a steady effort is made to shell the former out of its bed. An assistant now grasps the fundus uteri through the abdominal wall and pushes it steadily down into the pelvis until the end of the operation. If the serrated scoop be used, separation is to be effected by what its author terms[1] "a gentle pendulum motion" of the handle which gives the teeth of the blade considerable play, but must sometimes be changed for a distinct sawing motion; if either of the enucleators, it must be made to scrape or work around the tumor so as gradually to force it loose from the capsule. In all cases the tumor must be constantly "hugged" by the instrument until it is completely separated. From time to time segments of the growth may have to be cut away with scissors, and a fresh hold taken with the volsella. The danger with all enucleators is least in tumors near the cervix and greatest near the fundus uteri; and when the uterine walls are thin, this danger is enhanced. This is especially true of the spoon-saw, which has already been fatal in three cases in the New

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[1] Archives of Medicine (New York), Feb. 1879.

York Woman's Hospital; one in my own hands, the others in those of two of my fellow colleagues who are dexterous and experienced operators. In each case perforation occurred at the fundus, and death rapidly ensued from septic peritonitis.

As the tumor is separated from its capsule or its uterine nidus, it is drawn down and out, segments being cut off by scissors if it is too large for easy delivery. The uterus is then washed out with hot carbolized water (not with bichloride solutions), and the cavity stuffed lightly with aseptic cotton, which in twenty-four hours is to be changed.

Gradual firm traction is advised by Dr. Emmet for the removal of submucous or pedunculated tumors; and he reports a number of cases in detail[1] where this seems to have rapidly hastened natural expulsion by the womb. As the growth descends, it is cut off piecemeal with curved scissors, and ergot is given freely. When finally the pedicle can be reached, this is at once divided with curved scissors, and the remainder of the tumor is removed; the wound is then packed with aseptic cotton as above, and hot carbolized injections are used freely. The after-treatment in each method consists in the enforcement of complete rest, with the administration of morphia in moderation, and of liquid food and stimulants.

II. UTERINE FIBRO-CYSTS.—Until lately these tumors were thought to be exceedingly rare, but it is now known that, in a more or less perfect state of development, they occur quite often. Their chief clinical importance is due to the difficulty of distinguishing them from ovarian cysts—a difficulty quite insurmountable in some cases—but in the future, as the application of laparotomy to the treatment of uterine outgrowths becomes clearer, this embarrassment will be of less import.

In the vast majority of cases this neoplasm is simply a subperitoneal fibroid undergoing the process of softening; cystic degeneration is an error of terms, as no cyst-walls line the cavities thus formed. These are simply dilatations of the interspaces between the bundles of fibrous tissue, which fill with serum, and grow larger by the occasional breaking down of the trabeculæ between them. The fluid, which is probably true blood-serum, with a little mucin mixed with it, coagulates spontaneously on exposure to the air—a sign which Atlee thought prima-facie evidence of the existence of a fibro-cyst. Spiegelberg, Atlee, Wells, and Peaslee have all recorded cases of this exact description.

The *anatomical appearance* is that of a subserous fibroma, with firm fibrous base, arising by either a pedicle or a sessile base from the uterus. The upper part of the growth is softer, expanded, very elastic, and dimly fluctuating on palpation; of a duskier red or bluish color externally; not collapsing when tapped, but when opened seen to consist of many small cavities filled with bloody serum and flaky deposit. This explains the sensation of softening and imperfect fluctuation which these tumors always give when palpated.

The only *symptoms* to which they give rise are those of subperitoneal fibroids; their growth is variable, sometimes rapid, more often very slow; they do not influence menstruation; and they cause less detriment to the general health than ovarian cysts of the same size.

Their *differential diagnosis* is most difficult; but usually their imperfect fluctuation, their mobility with the womb, their evident connection with the latter as demonstrated by a rectal examination under ether, and careful examination of a little of the fluid withdrawn by aspiration, will suffice to indicate their nature.

Their only *treatment* is extirpation by laparotomy.

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[1] Op. cit., p. 587 *et seq.*

III. SARCOMATA OF THE UTERUS.—By sarcoma of the womb is meant a solid tumor of mildly malignant type, originating in the *connective tissue*, as carcinoma originates in the epithelium, and myoma in the muscular fibre, of the uterus. It is generally found in the body or fundus of the womb, rarely in the cervix, and occurs in two distinct forms or stages of development:—

1. Diffuse sarcoma of the mucous membrane.
2. Sarcoma of uterine parenchyma ("fibroid sarcoma" of Schroeder).

PATHOLOGY.—In the following brief statement of its pathology, reference will be made chiefly to the views of Virchow,[1] Gusserow,[2] and Cohnheim.

In the first variety of sarcoma there is a proliferation of cells from the submucous connective tissue of the cavity of the womb, or, as in Kimert's two cases and in one reported by Thomas,[3] of the cervix. These cells are round, small, rarely spindle-shaped, "and under their influence a soft, flabby, or villous tumor develops, which grows inwards into the cavity of the uterus." (Schroeder.) Often, according to Gusserow, this growth assumes at an early stage of development a polypoid or circumscribed form, and so passes insensibly into the second or fibrous type of the disease. It rarely ulcerates until a late stage, unless pressure be made directly upon it; still more rarely, as in a case reported by Gusserow, it penetrates the uterine wall, throws out sprouting masses like true cancer into the abdominal cavity, and affects neighboring organs. As it spreads, it often becomes associated with the product of epithelial cell-proliferation, and the mixed form of growth results which is termed by Klebs *carcino-sarcoma.*

The second, or circumscribed, form of sarcoma arises also from the connective tissue, but from deeper layers in the muscular coat of the uterine wall; like fibroma, it may be interstitial, submucous, or subperitoneal, but it is never encapsulated. It is found in round or cylindrical masses, generally in the submucous tissue, but extending into the deeper uterine parenchyma. When it assumes a polypoid tendency, it is always, according to Schroeder, found to have been developed from a degenerated fibroma. Its connection with uterine fibroids is, indeed, exceedingly close; and a microscopic section generally shows all the constituents of the myo-fibroma, with here and there centres of cell-growth around which round and spindle-shaped cells are found in profusion. These nodules do not ulcerate or break down easily, and often grow to a very considerable size; occasionally they become pedunculated and assume a polypoid form, when they may be extruded by uterine contraction like the fibroids which they so closely resemble. Generally remaining submucous, they may infiltrate the entire uterine walls. By metastasis, or by general systemic infiltration, they may affect neighboring tissues, though this rarely occurs; if removed, they are always recurrent in the same tissue.

ETIOLOGY AND MODE OF OCCURRENCE.—Of the causation of diffuse sarcoma of the uterus nothing definite is known. Of the circumscribed or fibrous form, Virchow and Schroeder think that there is good reason to believe it to be due to a special degeneration of myomatous or fibroid tumors.

Either form may occur at any period of menstrual life, or in advanced age; neither has been observed before puberty. Sterility seems to have a bearing upon the development of uterine sarcoma: of seven cases reported by Emmet, six occurred in sterile subjects, and eight in a series of fourteen collected by Schroeder; but of four cases of which I have accurate notes, three were in women who had borne one or more children. One of these (fatal after vaginal hysterectomy) was a case of sarcoma of the cervix, of which, in addition to the cases of Kimert and Thomas above cited, Galabin[1] and A. R. Simpson[2] have each reported an example. In sixty-three cases of uterine sarcoma reported by Gusserow in 1878, twenty-five were in sterile women whose ages ranged from 20 to 70 years.

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[1] Die krankhaften Geschwulste, Bd. ii. S. 350.

[2] Neubildungen des Uterus. Stuttgart, 1878.

[3] Diseases of Women, p. 569. 1880.

Symptoms.—The symptoms of uterine sarcoma are: (1) Menorrhagia or metrorrhagia; (2) Watery discharges, pinkish and inodorous; (3) Slowly increasing cachexia; (4) Pain, which is trifling in the diffused form or early stage, but very severe in the later stages of circumscribed sarcoma.

Diagnosis.—The conditions from which sarcoma is to be differentiated are fungous endometritis, uterine fibroid, carcinoma, and mucous polypus. From these the only distinguishing evidence, besides the characteristic cachexia, will be found in the microscopical examination of the scrapings removed by the curette. Even here the fact that epithelial cells are also removed adds to the difficulties of diagnosis.

Prognosis.—This is always grave; and unless the disease can be recognized in an early stage and the entire uterus removed, it is always fatal. This is due to the peculiar tendency of the disease to recur in the same tissue, while it is indisposed to invade other organs. In fatal cases its progress is less rapid than cancer; its duration has been variously estimated at from three (Simpson) to ten years (Gusserow). When recurring after removal, the development of the tumor is more rapid than before.

Treatment.—As soon as discovered the tumor should be removed. After thorough dilatation of the cervix, the surgeon should carefully examine the growth and its base; if sessile or pedunculated, should excise it with scissors, knife, spoon-saw, or écraseur; if diffused on the mucous membrane, should use the curette extensively and most carefully; in either case should try to effect a complete removal of everything down to the uterine parenchyma; should cauterize the base as carefully as possible with carbolic or fuming nitric acid; and should pack the cavity lightly with aseptic cotton pads.

When the disease is of the circumscribed fibrous form, and can be accurately diagnosed, extirpation of the uterus should at once be proposed as the only means of saving life.

IV. Carcinoma of the Uterus.—By carcinoma or cancer of the uterus is always understood cancer of the cervix, unless otherwise specified; in 686 cases of cancer of the womb, carefully collated from different authors, Schroeder found only 13 cases of authenticated cancer of the body of the organ, or a little less than two per cent.[3]

Pathology and Mode of Occurrence.—A scientific classification of uterine cancer on the basis of pathology is as yet impossible; and, for convenience of description, I shall retain the old-time division into: (1) Encephaloid; (2) Schirrus; (3) Epithelioma.

Of these it is customary to say that encephaloid and epithelial cancer are very common in the womb, while schirrus is extremely rare. But this only means that carcinoma of the uterus is rapidly fatal, too rapidly for it to effect the metamorphosis of tissue required before a hard schirrous mass can be generated. As a fact, encephaloid and schirrous cancer are only different phases of the same condition; in the one cellular elements predominate, and in the other fibrous tissue.

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[1] Trans. Lond. Obstet. Soc., vol. xx.

[2] Contributions to Obstetrics and Gynæcology. Edinburgh, 1880.

[3] Hart and Barbour, Manual of Gynæcology, p. 464. 1882.

The constitutional origin of cancer is now rarely held, although ten years ago most of the profession in Europe and in this country believed in it. Whatever be the cell-change that precedes its formation, it is now commonly thought a local disease which displays from the outset a profound tendency to poison the general system through the lymphatics, by venous absorption, and by rapid extension of the original disease to neighboring organs.

In the cervix, carcinoma usually begins in a degeneration of the connective-tissue cells, with increasing vascularity of the connective-tissue stroma. The new cells which are thus produced assume an epithelial character, and proliferate rapidly; and this may occur either just under the mucous membrane, on the vaginal surface of the cervix, or high up in the cervical canal. In the latter case, they soon destroy the mucous membrane and the submucous tissue, completely excavating the cervical canal. When it begins on the vaginal face of the cervix, the disease is apt to sprout down into the vagina as a cauliflower excrescence; the malignancy of this form has been questioned. After ulceration begins, we lose the power of distinguishing between these several forms of incipient disease.

When once fairly developed, its extension is very rapid, and it may invade the body of the womb, spread downward into the vagina, or extend into the pelvic connective tissue. In the latter case the progress is effected "either by a continuous infiltration of the adjacent connective tissue, or as a chain of nodules running in the direction of the utero-sacral ligaments."[1] After this it directly attacks the neighboring pelvic organs, the bladder most frequently and quite often the rectum, the ovaries, and the pelvic connective tissue. Perforation into the peritoneal cavity occurs in a large minority of cases.

SYMPTOMS.—*The local symptoms* are: (1) Metrorrhagia; (2) Pain; (3) Foul and offensive discharge from the vagina. The *general symptoms* are: (1) Rapid emaciation and exhaustion; (2) Peculiar cancerous cachexia.

The *hemorrhage* characteristic of uterine cancer is not simple menorrhagia, although that also commonly occurs; but consists of sudden gushes of blood, like the lesser hemorrhagic attacks in cases of *placenta prœvia.* This may occur while straining at stool, or during any unusual exertion, or spontaneously; incautious manipulation during a vaginal examination often occasions it. Although sudden in its onset, the hemorrhage ends in a prolonged drainage which often lasts several days or a week. It is mainly characteristic of the early stage of the disease, while the stroma is highly vascular, and before ulceration begins. It perceptibly affects menstruation, which is more prolonged and more profuse than usual; at middle life this is often mistaken for "the change of life." It is seldom, if ever, fatal.

Pain is rarely severe in the early stage of uterine cancer, and often is entirely absent. But as the disease advances, and either invades the uterine cavity or extends to neighboring tissues, it becomes prominent and is often excessive. The cause of this is multiple: new tissue-formations compress the nerve-filaments; subacute peritonitis is established around the advancing cancer; ulceration of the bladder or rectum is inseparable from pain in those sensitive viscera. It is greatest in schirroid cases, less severe when ulceration begins early at the original site of the disease. The pain is dull and throbbing, in the back and pelvis, or lancinating and acute, and felt in the groin and thighs, in accordance with the nerves affected; and it may usually be distinguished from that of the concomitant peritonitis by the tenderness and tension of the abdominal walls in the latter condition.

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[1] Hart and Barbour, op. cit., p. 428.

The vaginal discharge is characteristic, and almost pathognomonic. It is copious and watery in certain forms of epithelioma, but usually thin, mucoid, brownish, or streaked with blood, and peculiarly stinking in odor. In the former case there is little or no odor, and the flow is simply "a transudation of serum;" in the latter the foul smell is due to the rapid necrosis of tissue. Like the pain, it is chiefly found in the later stages of cancer, when ulceration is rapidly progressing, with molecular death of the newly-formed tissue. It is often acrid, and excoriates the pudenda and thighs; its distinctive odor makes the unfortunate patient offensive to all around her.

The general or constitutional symptoms of carcinoma uteri scarcely call for comment, as they are common to all forms of the disease. The most obvious are *wasting* or *emaciation*, and the peculiar *cancerous cachexia* or *cancerous facies.*

The former of these is due only in slight degree to the drain made upon the system by the cancerous discharge; it is mainly caused and maintained by disturbances of appetite and digestion, from the excessive toxæmia of the disease, and from the poisoning of the atmosphere which the patient breathes by the foul discharges from the womb.

The cancerous facies is indicated by a peculiar dingy-yellow hue of skin which, once acquired, is never lost. This is less yellow than in jaundice, and the white of the eye is not affected. It is caused in part by simple anæmia, and partly by a special form of blood-poisoning not fully understood; Barnes ascribes it to the decomposition of fecal matter and its absorption into the blood, and terms it *copræmia.* Probably uræmic conditions of the blood have much to do with its causation.

Diagnosis.—After the stage of ulceration begins, diagnosis is comparatively easy; in its earliest period, the microscope alone will decide the nature of the scrapings removed by the curette. Few patients, however, in actual practice, apply for relief before ulceration has begun. Then a vaginal examination discovers the cervix enlarged, indurated, and with everted lips; and springing from one of them a spongy mass, soft, friable, with dense, hard edges, either projecting free into the vaginal cavity, or creeping down the anterior or posterior vaginal wall. This may bleed slightly at the gentlest touch, and its contact leaves upon the examining finger a fetor which is unmistakable.

The persistence of this odor is remarkable, although a few applications, notably flaxseed meal and ground coffee, will promptly remove it. When withdrawn, the finger may be stained with blood or bloody mucus. The speculum should not be used, as it causes needless pain, and is liable to cause hemorrhage which is most difficult of arrest in some cases; the rectum should always be explored, both to ascertain if the malady has yet spread to it, and to obtain a better appreciation of the state of the upper pelvic cavity than can be acquired through the vagina. If there be much tenderness, a solution of cocaine should be freely applied. Finally, if doubt still remain—and cases on the border line will often occur in practice—the microscope should always be employed, and the débris thoroughly examined. Here the diagnosis will be confirmed by finding large aggregations of epithelial cells, with one or more nuclei, in a fibrous stroma with alveolar spaces. This may be said to be typical of cancer, although there is certainly no distinctive cancer-cell. In a word, before ulceration begins all of these tests will be requisite for a diagnosis, which, until then, is as difficult as it is after that period simple and certain to the experienced touch.

Differentiation.—The lesions with which carcinoma is likely to be confounded are: (1) Laceration of the cervix with much ectropion and erosion; (2) Diphtheritic inflammation of the cervix; (3) Syphilitic ulceration, or condylomata, of the cervix; (4) Retention of products of conception in the canal; (5) Sloughing polypi or fibroids; (6) Sarcoma of the cervix.

From what has been said above, it would seem that a differential diagnosis of cancer could easily be made from any of these conditions. As a fact this is not so. In the early stage (precisely when it is most important for the patient's future) this is well nigh impossible; and, without microscopic aid, quite impossible in some cases. If this be true with experts, and it *is* true, the reader may infer how often errors of diagnosis are made by the mass of practitioners. I have frequently seen cases in consultation (and can recall two as occurring within the last six months), where a wrong diagnosis, or no diagnosis, had been made, although sprouting epithelioma or encephaloid of the cervix filled the entire vagina. Another source of confusion here is due to the fact, pointed out by Emmet, and also by Ruge and Veit, that some of these lesions (as, for instance, the old erosions of a badly lacerated cervix) merge insensibly into malignant disease. Spiegelberg's tests—of the mobility (or immobility) of the cervical mucous membrane, and the dilatability of the cervix by tents—are fallacious or impracticable. Only the minutest and most painstaking care, investigation of the antecedent history, and accurate vaginal, rectal, and *microscopical* examination, will enable the surgeon to reach a correct verdict.

PROGNOSIS.—In carcinoma uteri the prognosis is so grave that we concern ourselves chiefly with the question of the possible *duration of life*, and not with that of ultimate recovery. That one, or possibly two, seemingly authenticated cases[1] of spontaneous cure should be on record is, perhaps, an interesting fact in medical history; but it in nowise affects the result of statistical inquiry. This is that the patient's average expectation of life is from one to three years from the date of the first appreciable symptoms, if no effort be made to treat the disease; and, as far as can be inferred from the statistics of Schroeder, M. Hofmeier, and A. Martin, that from two to five years of life may be added to this if vaginal, or supra-vaginal, extirpation be performed.[2] When death (without operative interference) occurs, it is usually from uræmia, or other form of septicæmia, peritonitis, exhaustion, or (most rarely) hemorrhage. The first-named of these causes of death is much more frequent than has been supposed; peritonitis is rarely fatal unless complicated by perforation; general exhaustion and marasmus are quite common.

TREATMENT.—In modern practice, the treatment of uterine cancer is essentially surgical. No effort will, therefore, be made to describe here the medical treatment which has been vainly attempted in the past. The treatment may be either *palliative* or *radical;* in the near future, it may perhaps be termed *curative*, for, with the constant improvement of our present methods, the possibility of our treating the disease successfully seems largely dependent upon the possibility of our detecting it in its earliest stage. Unhappily at present this is often beyond our ken; and the facts that the inception of the malady is overlooked, that the nature of the uterine tissue is especially favorable for its development, and that it is impossible to remove secondary pelvic deposits

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[1] Barnes, Diseases of Women. London, 1878.

[2] Centralblatt für Gyn., Nov. 1885.

(as can be done in the removal of mammary cancer), sufficiently explain the imperfection of our results.

1. The *palliative treatment* may be summed up in a few words. Its object is the relief of pain, hemorrhage, and offensive discharge; and the improvement of the patient's general health.

Pain is remediable only by opium or its derivatives, which may be given either hypodermically or by rectal suppository.

Hemorrhage may be arrested by the vaginal tampon, by styptics, or by the thermo-cautery; and its recurrence may be prevented by the use of mild astringent injections, of which the best is a solution of acetate of lead and alum; the iron salts are objectionable, and the weaker astringents, like borax and tannin, are of no avail.

Foul and offensive vaginal discharges are most difficult of control, but are also best treated by vaginal injections. Here disinfectant and deodorant additions may be made to the astringents above recommended; permanganate of potassium, carbolic acid, listerine, Bobœuf's phénol-sodique, may all be used in this way with good effect. Weak solutions of bromine are also sometimes employed, but their odor is offensive. The irritation of the external genitals caused by these acrid discharges is best allayed by the free use of an ointment of cocaine (4 per cent.) and vaseline.

The *nutrition and general health* of the patient require constant attention, whether the object be to prepare her for a surgical operation, or merely to retard the exhausting progress of the disease. The indications here are to maintain purity of the surrounding atmosphere, to give ample supplies of nutritious food, and to prevent constipation.

2. The *radical treatment* of uterine cancer contemplates the extirpation of the diseased tissue. If this could be certainly and completely done, carcinoma would cease to be an incurable disease. But no test yet devised by science, suffices to show how far apparently healthy, contiguous tissue is already infiltrated with cancer germs, or just when the general system has been poisoned by the local disease. All that we know is that adjoining tissues, though *apparently* healthy, are infiltrated to a much further point than formerly supposed; and that after ulceration begins, surgery can only postpone the fatal issue.

In selecting either of the following methods, it must never be forgotten that success is dependent almost wholly upon the *thoroughness* with which ablation of the diseased tissue is effected.

The modes of accomplishing this are: (1) Cauterization; (2) Scraping or curetting; (3) Amputation of the cervix; (4) Extirpation of the uterus, vaginal or abdominal.

(1) *Cauterization* may be effected with mineral acids, such as the nitric or muriatic, with bichloride of zinc or bromine, with the thermic or galvanic cautery, or with the actual cautery. If chemical agents be used, their application should always be followed by that of the thermo-cautery; and the utmost care should be taken first to dry the surface, then to cauterize extensively, cutting away all loose and necrosed tissue, and finally to dry the surface again and to apply an aseptic tampon. In epithelioma and analogous conditions of the cervix, Churchill, Noeggerath, and others, have obtained excellent results in this way; but the treatment requires frequent repetition, and its applicability is very limited.

(2) *Curetting* is best done with Simon's scoop or Sims's sharp curette, which here finds its greatest utility. Cases in which the disease is rapidly spreading to the vaginal walls, or in which ablation of the cervix is impossible, are most suitable for this treatment. The curetting should be firm and thorough, until a layer of healthy tissue has been removed, and then should be followed by the use of the thermo-cautery as before; rigid antiseptic pre-

cautions must be taken throughout the operation, and an aseptic tampon should subsequently be applied and maintained in the vagina for a week or ten days.

(3) *Amputation of the cervix* is demanded when the cancerous disease is apparently limited to the cervix uteri, or when, beginning there, it has invaded other tissues only to a limited degree. It includes: 1. Amputation of the vaginal portion only; 2. Supravaginal amputation (Schroeder's method).

The first (and much the simpler) of these operations may be performed with the knife or scissors, the écraseur, or the galvano-cautery wire. Each of these instruments has its advantages and drawbacks. If the former be selected, the cervix is to be split bilaterally up to the vaginal junction, wedge-shaped portions, including all the diseased tissue, excised from the anterior and posterior lips, and the flaps so stitched together as to unite cervical to vaginal mucous membrane; after which the lateral incisions are to be closed by silver sutures. This is Marckwald's method, and in my hands it has seemed satisfactory when the cervix could be drawn down to the vulva; but, as the hemorrhage is apt to be profuse, it is unsuitable for cases in which the uterus is fixed.

If *écrasement* be preferred, the curved écraseur of Simpson should be used, as this obviates much of the traction upon the uterus which must otherwise be made. The chain must be passed as high as possible upon the cervix—it involves no danger to either bladder or Douglas's pouch if the womb be not dragged down—and it must be tightened with extreme deliberation, fully ten minutes by the watch being allowed for its cutting its way through. Both this and the previous operation may be done under continuous irrigation with a 2-per-cent. carbolic acid solution. Ether of course is used, and the patient is kept in Sims's left lateral position.

Should the *galvano-cautery* be used, as is generally done in New York, the wire-loop is passed (cold) at the same height as the écraseur-chain; and, when tightened, the current is slowly turned on so as to heat the wire only to a *red* heat; more than this is undesirable, as it is extremely important that the wire should burn through the tissue very slowly. The cervix is apt to slip unless it be steadied by volsella, or, better, with Thomas's screw forceps[1] with shoulders, which also steadies the wire. The best galvano-cautery batteries in use in this country are Byrne's and Dawson's; and to Dr. John Byrne, of Brooklyn,[2] the American profession is more indebted than to any one else, for his intelligent labors in perfecting this method of treatment.

In the after-treatment of these cases, careful and efficient tamponing of the vagina for a week or ten days is most important, for the danger of secondary hemorrhage is much greater than is commonly supposed. I have seen most alarming hemorrhage on the seventh day, and Thomas on the ninth day, after operations conducted in this manner; and nothing can be juster than that author's warning that "reliance on the hemostatic powers of the electro-cautery in this operation is a delusion, and a most dangerous one."

Supravaginal amputation of the cervix (Schroeder's operation) is indicated when cancerous infiltration is thought to have passed still higher up the womb, and is thus performed: The cervix is drawn down to the vulva by stout volsella forceps, or by two ligatures passed deeply through the parametria. A curved incision is then made in the anterior vaginal vault, deeply into the submucous tissue. The cervix is drawn forward and a similar incision is made through the posterior vaginal vault, the ends of the incisions meeting on either side. The bladder is rarely or never injured in front; and

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[1] Op. cit., p. 593.

[2] Amputation and excision of the cervix uteri, Trans. Am. Gyn. Soc., vol. ii. p. 57 *et seq.*

Douglas's pouch may be opened with impunity behind. At the sides of the cervix the connective tissue is denser and more vascular, and here scissors must be used, and ligatures perhaps applied to vessels. When the cervix is now freed, it is incised *in front* as high as may be needed, and as deeply as *into the canal.* The anterior wall of the cervix is stitched to the anterior vaginal wall, which secures the cervix against retraction, while the posterior wall is divided and the amputation finished. It is further steadied by the sutures passed through the anterior wall, which are purposely left long. The posterior cut surface of the cervix is then sewed to the posterior vaginal wall, and the operation is completed by uniting the lateral ends of the vaginal wound with sutures passed deeply into the uterine tissue to guard against hemorrhage. By maintaining steady traction upon the cervix during the entire operation, there is no danger of wounding either the bladder or the ureters. As to the value of this operation, it may be said to be not very dangerous to life, and yet not very satisfactory in its results, although the future will doubtless make it more so.

In October, 1885, Dr. M. Hofmeier reported[1] that, at the Berlin Institute, there had been performed up to January 1, 1884, altogether 83 supravaginal amputations of the cervix: 8 patients had died; in 19 cases the result remained doubtful; in 35 relapse had occurred within two years; 21 patients had remained free from disease for two years or longer. In 1882, Dr. W. H. Baker,[2] of Boston, published the results of his experience in removing a much larger segment of the diseased uterus. His procedure is analogous to Schroeder's, but more radical; he does not open the peritoneum behind the cervix, and, instead of excising the neck at the internal os, he takes a large conical section out of the uterus with the apex approximating the fundus. Of six patients thus treated all were living at the end of six years, and the disease had returned in only one within that time.[3] After excision of all the diseased tissue, Baker uses the Paquelin cautery thoroughly upon the raw surface.

(4) *Extirpation of the uterus* may be done by the vaginal method, or by abdominal section (Freund's operation).

For the technique of vaginal hysterectomy we are mainly indebted to Schroeder, although A. Martin, of Berlin, has up to the present time performed the operation most frequently (72 cases, with 14 deaths). Its applicability and its advantage over amputation of the cervix, where cancerous disease has infiltrated most of the uterus, must be obvious. The mode of performing this operation will be described hereafter.

AFFECTIONS LIKELY TO BE MISTAKEN FOR OVARIAN OR UTERINE TUMORS.

Under this heading will be described certain affections which may be mistaken for ovarian or uterine growths, and which may themselves become the subject of operative treatment.

CYSTS OF THE BROAD LIGAMENT.—Parovarian cysts, or cysts of the broad ligament, are comparatively rare; but, at all periods of development, and especially at an early stage, they are liable from their position and their ready fluctuation to be mistaken for ovarian cystomata. Indeed, at an early age, it is well-nigh impossible to distinguish between them. They are retention-cysts only, and originate in the parovarium, Wolffian body, or body of Rosenmüller, which lies between the folds of the broad ligaments near its margin. One or more of the ducts, of which this organ is mainly composed, undergoes slight dropsical distention from a casual irritation; this increases under favorable conditions, and the sac becomes distended rapidly and to a large size. The walls of these cysts are thin, and lined with cylindrical epithelium, which is often ciliated; occasionally they contain non-striated muscular fibre.[1] They are rarely pedunculated, generally springing directly from the surface of the broad ligament, of which circumstance advantage is taken in their enucleation when they are removed by laparotomy. They contain a clear, crystal-like serum, which contains little or no albumen, is of low specific gravity, and has an opaline tint when freshly drawn. They are nearly always unilocular, and as a rule do not return after tapping, although recurrence has been noted in a number of recorded cases. Killian,[2] who has lately made an exhaustive study of the anatomy and histology of these cysts, thinks that they contain no element which can be termed pathognomonic.

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[1] Amer. Journ. of Obst., Feb. 1886, from Centralblatt für Gyn.

[2] Amer. Journ. of Obst., April, 1882.

[3] Trans. Amer. Gyn. Soc., vol. ix. p. 229.

Their proper *treatment* is by tapping, which is nearly always curative; or, if peritonitis be feared, by laparotomy and enucleation. The latter is not difficult, as adhesions are rarely found. If there be signs of hemorrhagic oozing from the site of attachment in the broad ligament, a drainage-tube must be used.

PELVIC HÆMATOCELE.—Pelvic hæmatocele, or *retro-uterine hæmatocele*, as it is often called, is a symptom, not a disease; and a symptom referable to many diverse causes. But its prominence is such, and the conditions attending its occurrence are so alarming and far-reaching, that it is naturally regarded as the malady itself.

Definition.—Pelvic hæmatocele is an effusion of blood into the pelvic cavity, either into or behind the pelvic peritoneum. In the vast majority of cases the blood settles by gravitation into the posterior cul-de-sac, whence the term *retro-uterine hæmatocele;* but, as exceptions to this rule occur, the more comprehensive term *pelvic hæmatocele* will here be retained.

Etiology.—The causation of pelvic hæmatocele is multiple, and the variety of conditions that lead to it justify the above statement of its symptomatic character. The main sources of the hemorrhage may be classed under the following heads: (1) Reflux of blood from the uterus; (2) Direct outflow from the pelvic, or the lower abdominal, bloodvessels; (3) Metastasis, or transudation, in certain blood diseases.

Cases belonging to the first of these classes—quite frequent, although less so perhaps, than those of the second—occur almost exclusively during menstruation. The regurgitation may be due to suppression of the flow by cold, fright, or mechanical injury; unusual exercise, or violent coitus during menstruation; or occlusion of blood within the uterine cavity or the Fallopian tubes by stenosis of the cervical canal. In the second category are classed all cases due to rupture of the vessels in the pampiniform plexus, of the uterine veins, or of the bloodvessels developed in the false membrane of pelvic peritonitis. The rupturing ovisac of an extra-uterine pregnancy will lead to similar results if the rupture should occur at an early date; or the blood may come from the hyperæmic mucous membrane of a Fallopian tube. Hart and Barbour[3] think that, of all these causes, "rupture of the Fallopian tubes and ovarian pregnancies are the most common." This statement is certainly open to question. Illustrations of the third class may be found in the internal hemorrhages that occur in the course of scorbutus, in hemorrhagic peritonitis, and in many of the milder forms of chronic septicæmia. Whatever be the cause of the hæmatocele, there is always a distinct, and sometimes a very considerable hemorrhage into the peritoneal cavity, or behind it; and the location of the resulting blood-collection determines the specific name of the tumor. Thus it is retro-uterine, ante-uterine, or peri-uterine hæmatocele; the term *hæmatoma* indicates a blood-tumor in the connective tissue of the pelvis.

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[1] Spiegelberg, Archiv für Gyn., Bd. i. S. 482.

[2] Ibid., Bd. xvi. H. 3.

[3] Man. of Gyn., p. 167.

Symptoms.—The general and subjective symptoms of hæmatocele are: (1) Pain in the hypogastric region; (2) Faintness and profound exhaustion; (3) Metrorrhagia; (4) Uterine colic; (5) Coldness of the surface of the body; (6) General evidence of sudden loss of blood; (7) Pressure on the rectum and bladder. Some of these symptoms—the menorrhagia for instance—may be quite wanting; the others are more or less distinctly marked, and in each case are somewhat variable. The crucial test, as Thomas[1] has pointed out, lies in the *combination* of the symptoms of extreme loss of blood with those of pelvic pressure and of interference with the pelvic viscera.

Physical Signs.—These vary in accordance with the period of the development of the disease. If a vaginal examination be made immediately after the attack, little or no change will be felt from the ordinary state of the pelvis. But within a few hours this is all changed. Now, especially if the effusion be retro-uterine, the uterus will be felt pushed upwards and forwards; and, behind it, a boggy softish mass, evidently containing fluid, smooth, painless on pressure, and obscurely fluctuating. In a day or two this is more circumscribed, and much harder; rectal examination now confirms the surgeon's previous impressions, and more clearly maps out the area affected; indeed, it is invaluable as an aid in diagnosis.

If the blood is in Douglas's pouch, there is a distinct tumor-like projection into the vagina, varying, however, with the patient's position until coagulation takes place. When the effusion occurs chiefly into the broad ligament, the signs are vaguer, but still the puffy tumor can be felt following the line of the ligament; and this, after the occurrence of severe collapse, is indicative of nothing but hæmatocele.

If the effusion be general—throughout the pelvis—the patient may sink from great loss of blood. After reaction, the usual sign of a generalized boggy mass, which pits on pressure but becomes harder from day to day, will guide us towards a correct inference. In large effusions, abdominal palpation will suffice to feel the tumefaction, but cannot accurately map it out; conjoined palpation is more satisfactory. In the few recorded cases in which the outflow has been confined to the anterior cul-de-sac, the uterus has been pushed toward the rectum, or retroverted.

Differential Diagnosis.—Hæmatocele may readily be mistaken for (1) Extra-uterine pregnancy; (2) Perimetritis, with abscess or severe effusion; (3) Retroversion of the uterus; (4) Ovarian cyst, or fibroid on the posterior wall of the uterus; (5) Retention of menses.

In *extra-uterine pregnancy*, there is a gradual appearance and increase of the tumor: in hæmatocele the onset is always sudden. Menstruation is suppressed, and corroborative signs of pregnancy are present. In *perimetritis* with or without fluid accumulation, there is a distinct inflammatory history; there is no sudden onset or menorrhagia. The tumefaction is lateral, not posterior to the womb; it is tender to the touch and is hard at first, with increasing softening as time goes on. In hæmatocele the opposite is observed. In *retroversion of the uterus*, the sound will at once settle the question, unless pregnancy contra-indicate its use; and there will be no symptoms of loss of blood. *Neoplasms*, either solid or cystic, are painless, unaccompanied by metrorrhagia or signs of internal hemorrhage, and, in the case of fibroids, so hard and lobulated as to be obvious. In *retention of the menses* there is amenorrhœa, stenosis of the cervical canal, and a prominent tumor which is unmistakably uterine.

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[1] Op. cit., p. 515.

Prognosis.—In most cases of hæmatocele the prognosis is favorable; but this statement needs qualification. In the subperitoneal form it is much better than in intra-peritoneal hemorrhage. When extra-uterine pregnancy, or the rupture of a varicose vein, is the source of the hemorrhage, the chance of recovery is very slight. When death occurs, it is from direct exhaustion from loss of blood, from shock, from peritonitis due to the immediate blood-effusion or to rupture into the peritoneal cavity of the subperitoneal tumor, or from subsequent septicæmia.

Course and Termination.—In most cases the course of hæmatocele is towards a slow but steady recovery. Voisin thought that nearly four-fifths of all known cases pursued this course in about six months. Instead of undergoing gradual absorption, however, the contents of the tumor may be discharged into the rectum, the vagina, or the peritoneal cavity; fatal results follow the latter occurrence, and when death does not ensue immediately, septicæmia often follows with results that terminate in death more slowly.

Treatment.—This should be addressed to arresting the hemorrhage and to promoting the absorption of the effused blood. For the first purpose it is mainly expectant. The patient is to be put to bed immediately, and kept at perfect rest, with ice-bags on the hypogastrium, and hot bottles at the feet and legs. If there be threatening of collapse, hypodermic injections of brandy and ether should be given, with enough morphia to quiet nervous disturbance and to relieve pain. Ergotine, or ergot and gallic acid, may be given by the mouth, or hypodermically; but little or nothing is thus gained. Brandy, whiskey, or iced champagne may be given in small quantities by the mouth. The question of laparotomy, to reach at once the source of the hemorrhage and arrest the flow, will often arise. Theoretically, this should be the cardinal point of treatment in severe hemorrhages; but our present means of diagnosis are insufficient to warrant its recommendation, and I know of no case in which it has been done successfully. In the future it will certainly be accomplished. In the later stages, absorption is to be steadily promoted unless septicæmia threatens; then the hæmatoma is to be evacuated and drained through the vagina, or, as Mr. Lawson Tait advises, by abdominal section.

For carrying out the former plan, either a trocar, a bistoury, or the galvano-caustic knife, may be employed; the tumor is to be opened from the vaginal surface (with the patient anæsthetized, on her back, or in the left lateral position), and carefully washed out with carbolized hot water, a well-fitting drainage-tube being kept in the opening. Every day for a week or two this irrigation should be practised afresh, and always under antiseptic precautions.

If laparotomy be adopted, every effort should be made to draw up the sac-walls, so as to unite their edges to those of the abdominal wound. A drainage-tube is to be inserted, and through this the sac must be kept steadily free from pus as before. The progress of such cases is naturally much slower than after an ordinary ovariotomy; but, in the hands of skilled laparotomists, they promise excellent results for the future. In 1882, Mr. Tait had operated with uniform success in this manner upon twenty cases[1] of pelvic abscess, mostly instances of hæmatocele in their inception; and since then has doubtless had many others.

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[1] Dis. of the Ovaries, p. 351. 1882.

ILIO-PELVIC ABSCESS.—In another part of this work[1] the pathology and treatment of ilio-pelvic abscess have been fully described by Mr. Henry Morris, of London. To his article the reader is referred for general information; and only such points as may tend to elucidate the relation of these abscesses to ovarian tumors will here be considered.

The origin of ilio-pelvic abscess is multiform. Generally speaking, it is due to suppurative perimetritis; and only in exceptional cases is it referable to suppuration in a hæmatocele, or in an ovarian cyst. In the vast majority of hæmatoceles, the blood-clot is either slowly absorbed or is permanently encysted; in suppurating cysts, the condition is recognized and relieved by surgical interference, or the patient dies from hectic and septicæmia, and far more often than we should infer from analogy in other parts of the body. Rupture into the adjoining connective tissue is extremely rare.

When pus accumulates in the pelvic connective tissue, it is always due to some general systemic cause in addition to the perimetric inflammation, such as struma, general debility from anæmia, the puerperium, hospitalism, syphilitic dyscrasia, or previous tendency to septicæmia or pyæmia.

Symptoms.—The symptoms of pelvic abscess are those of confined purulent collections elsewhere. Chills, fever, sweating—which should never be mistaken for malarial symptoms—characterize the beginning of the disease; dysuria, rectal tenesmus, and pelvic pain, are also felt in proportion to the size and special location of the pus-collection. General exhaustion is very marked.

The *physical signs* are those of a fluctuating tumor, which is most perceptible from the rectum, and which can often be mapped out by conjoined manipulation, although in many cases the surrounding inflammatory deposit makes the fluctuation extremely obscure. A positive diagnosis is sometimes impossible without the use of the exploring needle.

The *course* of pus, imprisoned in the pelvis, is very uncertain. It may remain for an indefinite time without "pointing" in any direction, or it may evacuate itself through any part of the pelvic parietes: upward into the peritoneal cavity; downward through the rectum, vagina, or bladder, one or all; through the foramina, then emerging upon the thighs or buttocks; or, finally, through the abdominal walls. The rectum and vagina offer the commonest and, happily, also the safest channels of escape in such cases.

Differentiation.—The conditions for which this state of disease is most likely to be mistaken are: (1) Pelvic hæmatocele; (2) Pelvic cellulitis, in the stage of softening; (3) Suppurating ovarian cyst; (4) Extra-uterine pregnancy.

If the history can be ascertained with a fair degree of accuracy, the first of these may readily be excluded; for the sudden onset and hemorrhagic symptoms of *hæmatocele* are unmistakable. The physical signs are very similar. When suppurative inflammation has occurred in an hæmatocele or hæmatoma, the conditions are inseparable.

The systemic symptoms in pelvic abscess will usually suffice to guide us in distinguishing it from any stage of *cellulitis.* If doubt still remain, the exploring needle must be carefully used, and will commonly decide the question. The employment of this test is, however, fraught with some danger.

From *ovarian cysts*, in their usual condition, the diagnosis cannot be difficult. The smooth and elastic surface of the cyst, its mobility in most cases, and the evident non-implication of the pelvic tissue, all aid us in this respect; while the patient presents none of the serious constitutional symptoms above enumerated as characterizing abscess. When the cyst has undergone suppuration, the difficulty is enormously increased, unless the antecedents of the patient are well known. If so, the existence of a tumor will probably have been known for years—a tumor which could not exist in abscess without immediate breakdown of the general health. As a last resort, an exploratory puncture should be made—from the vagina, if possible, or, if the swelling be too high, through the abdominal wall. Should the needle penetrate a pelvic abscess, only pus, or blood and pus, will be obtained. If there be an ovarian cyst, enough ovarian fluid may be secured with the pus to give some of its distinctive tests.[1] In this case the risks of ordinary explorative puncture are much increased, and a serious peritonitis is so liable to follow that we should never use the needle without being prepared to follow the puncture by a laparotomy at once if it be indicated. The large aspirator is here more unsafe than the hypodermic syringe, to which, however, I am accustomed to attach a needle at least twice or three times as large as that used for hypodermic injections.

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[1] See Vol. V. pp. 1024 *et seq.*, *supra.*

In *extra-uterine pregnancy*, the physical signs are not dissimilar, but the constitutional symptoms and the history are totally different. Instead of hectic, chills, and sweating, the symptoms of pregnancy will be found to coexist with otherwise good health; and to this will be added, after the fourth month, more or less distinctive evidence of fœtal movements. Menstruation, which may be regular in pelvic abscess, will have been suppressed.

Prognosis.—In all cases of pelvic abscess the prognosis will be grave, and there will be cause for well-founded anxiety. If, however, the abscess be low —near the pelvic floor—and within easy reach of drainage from the vagina or rectum, the outlook will be more favorable than when high in the pelvis, and debarred from access by thick balls of deposited lymph. Nonat[2] and Thomas[3] think the prognosis much worse when the abscess opens high, "and by two points of exit, as, for example, the bladder and the bowel."

Treatment.—Only two plans of treatment are applicable to cases of pelvic abscess: the expectant and the surgical. The former is justifiable when it is apparent that the pus is advancing towards the surface of the vagina or rectum, and when no pressing symptoms exist. This, however, is undeniably hazardous; for, as in one of Simpson's cases, the abscess may burst into the peritoneal cavity, while it seems to be advancing downward toward the vagina. But, when this process ceases, assuming that the existence of pus has been already demonstrated, its evacuation must be attempted as soon as possible. Up to this point, the treatment will have consisted in the administration of carefully selected and nutritious food, with quinine and other tonics, and in the application of hot fomentations or poultices to the abdomen, and of hot vaginal injections, with careful regulation of the bowels and the avoidance of either constipation or the use of drastic cathartics. All this is palliative only, but it aids in paving the way for what is to come.

When a decision to operate is once reached this should be done without hesitation or delay. The choice will lie between aspiration or incision through the vagina, on the one hand, and laparotomy on the other. In this country, the former method has been in vogue; but Tait, Martin, and Hegar have done so much to perfect the abdominal incision, that little doubt remains that this will become the favorite plan in the early future. Rectal puncture or incision is so rarely practicable that it may be left out of consideration.

If the vaginal operation be selected, after once locating the pus with an exploring needle, Dieulafoy's aspirator, or one of its modifications, is used to thoroughly exhaust the abscess, and then to wash out the cavity with hot carbolized water; or, a grooved exploring-needle being used, as soon as the pus is seen to flow along the groove a small bistoury is slid along this, and the abscess is then opened with sufficient freedom to permit of its being washed out, and of a drainage-tube being inserted through the opening. This is to be kept in by suture or such other device as the operator may prefer, and the pus-cavity is to be regularly washed out through it with some warm disinfectant.

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[1] See page 792, *supra*.

[2] Mal. de l'Utérus, etc.

[3] Op. cit., p. 504.

If laparotomy be preferred, a moderately short incision should be made as in Battey's or Tait's operation; the abscess, having been reached as gently as possible, is opened and washed out carefully; and, if at all possible, its walls are brought up so as to be fastened to the edges of the abdominal wound. A glass drainage-tube is now inserted into the abscess-cavity, and, if need be, another into Douglas's *cul-de-sac*; the "toilet of the peritoneum," to borrow the German phrase, is most carefully made, and the wound is closed around the drainage-tube (or tubes), especial care being taken not to make too much traction upon the line of union between the walls of the sac and the edges of the abdominal wound. The subsequent treatment is as usual.

Operations for Ovarian and Uterine Tumors.

Ovariotomy.—By ovariotomy is meant the extirpation or removal of an ovary that has undergone cystic or other degeneration. It is practised by either the vaginal or the abdominal incision; but, unless otherwise specified, the abdominal method is always understood.

Vaginal ovariotomy is necessarily limited in its application, and is very rarely employed. But, in the case of small cysts low in the pelvis, or even in cysts of larger size that have become "dislocated" into Douglas's pouch, and are seemingly free from adhesions, it has no doubt a useful future; for, if done with ordinary skill, it is obviously less dangerous than laparotomy. It was first adopted by Prof. Thomas,[1] in 1870, since which time eight or ten cases have been reported—all I think in this country. The procedure is as follows: The patient is etherized, and turned in the semi-prone position. With Sims's speculum and a depressor the upper vagina is kept on the stretch, and the posterior wall is incised behind the cervix. The tumor is then carefully examined, and tapped with either a small trocar or an aspirator; and, as the sac empties itself, it is drawn gently with tenacula or forceps through the incision into the vagina. Then comes the difficult part of the operation: the application of a ligature to the pedicle. This is chiefly due to the awkwardness of all such manipulations at the top of the vagina. A double ligature of thin carbolized silk is passed through the pedicle where it emerges into the vagina, is tied firmly on each side, and (after cutting away the cyst) is either returned to the cavity of the pelvis or is stitched into the vaginal wound; except this suture for the fixation of the pedicle, the vaginal incision may be left open to granulate. It remains as a vent for any retained pelvic secretions, and the union by granulation is as firm as that by first intention. Should the discharge become fetid, or the temperature run high, the pelvic cavity may be syringed out with weak carbolic solutions. The results of this operation have so far been satisfactory.

Abdominal Ovariotomy.—Of this operation—one of the greatest triumphs of modern surgery—a more careful and detailed description is necessary. It is of modern date, and of American origin. In spite of the efforts of European writers to claim for others the honor of priority, nothing in the history of surgery is more certain than that ovariotomy owes its first performance, and its first success, to Dr. Ephraim McDowell, of Kentucky. This bold and resolute surgeon matured all the steps of the operation beforehand; and with such imperfect assistance as he could obtain, and without the aid of anæsthetics (which we deem indispensable), he removed a large polycystic ovarian tumor, and had the satisfaction of seeing his patient recover. This was in 1809; and the operation was not only successful, but the patient lived for twenty-five years subsequently. After this McDowell operated thirteen times, with eight recoveries and five deaths; and his name and fame, beyond all others, should be honored as those of the pioneer in ovariotomy. A condensed and well-written summary of the history of this operation, and of its progress in different countries, will be found in Dr. T. Gaillard Thomas's classical work,[1] to which the reader is referred for many interesting items which cannot here be reproduced.

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[1] Dis. of Women, p. 731; Goodell, Trans. Am. Gyn. Soc., p. 257. 1877.

In this country, within the present and past generations, Kimball, Atlee, Peaslee, Thomas, Goodell, and Homans have contributed most largely by precept and example to the perfecting of ovariotomy, and to establishing it in the confidence of the profession. In Great Britain, similar and illustrious service has been rendered by Baker Brown, Wells, Keith, Thornton, Bantock, and Lawson Tait: while in Germany, where at first an invincible prejudice existed against it, some of the most brilliant successes on record have been obtained by Schroeder, Martin of Berlin, Billroth, Spiegelberg, Hofmeier, and Olshausen. In France, Italy, and the rest of Europe, ovariotomy has been less enthusiastically practised, and its records are more limited; but it may safely be said that there is not a civilized country on the globe where it has not met with more or less success.

Assuming that ovariotomy is contemplated in a given case, the two most important preliminaries are the decision *when* to operate, and the preparation of the patient. Sir Spencer Wells laid down the rule to wait until the general health of the patient should begin evidently to fail; and this injunction, supported by the immense weight of his name, and based upon the former large mortality of the operation and the uncertainty of success, was concurred in by Atlee and Peaslee, and still weighs like an incubus upon many a timid operator.

But, since "Listerism" and modern improvements in the technique of ovariotomy have enormously diminished this mortality, the generally accepted rule is to operate as soon as the cyst has distinctly risen from the pelvis into the abdominal cavity. At this time the intestines that would otherwise underlie the abdominal incision are displaced by the tumor, the peritoneum is somewhat stretched and rendered insensitive, and we take advantage of the retained strength of the patient, which often turns the scale in her favor after the shock of a severe operation. When once the diagnosis is certain, there can be no gain in waiting longer in a disease that is inevitably fatal.

It will of course be remembered that most women apply first for advice at this stage, as they then for the first time become aware of the existence of a "lump" or tumor.

The preparatory treatment is simple enough. Some surgeons, who have excellent success, pursue none at all. But, bearing in mind that the patient must preserve an enforced quiet in bed for a week or ten days, and that the bowels must not be moved during that time, it is wiser to give for a week previously a mild laxative each night—a mixture of sulphur and magnesia being the best—and for the last two or three days to give only broths, milk, and gruel as food; with this some mild tonic or a little stimulant may be combined, if the general health be feeble. A daily sponge-bath completes the preparatory treatment. The urine should always be most carefully examined, and, if albuminous, the case should be retained under observation a short time longer. Dr. Thomas is accustomed to give "from twelve to fifteen grains of quinine with a quarter of a grain of morphia five hours before the operation." This, of course, is to anticipate and prevent surgical shock, but in my hands the plan has not answered well, and I have abandoned it, as in more than one case it has upset the stomach, and disturbed the nervous system. For five or six hours before the operation no solid food must be taken. Immediately before operating, the bladder must be carefully emptied.

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[1] Op. cit., pp. 722 *et seq.*

The requisites for the operation are the carbolic spray—to be used *before* but not *during* the operation; solutions of carbolic acid and mercuric bichloride; two good bistouries; two good directors, one broad; one dozen artery forceps—Sims's, Wells's, or Esmarch's; half a dozen long adhesion-forceps—Tait's or Keith's; two large sac-forceps—Nélaton's; two tenacula—small; two tenacula or sharp hooks—large; two trocars—Wells's or Emmet's; two pairs of scissors—straight and curved; one aneurism-needle; one Peaslee's carrying needle; clamp (in reserve)—Dawson's or Thomas's; ligatures—catgut, Chinese silk—two of large braided silk; needles, some threaded in advance; cautery—Paquelin's if possible; drainage-tubes; iodoform gauze; and "protective" dressings. The sponges, which have been purposely omitted from the above list, are most important and a constant care to the surgeon. There should always be a definite number in use, say one dozen, no more and no less; and of these one half should be good-sized, medium sponges for hand use; three large, thin, and flat, for pressing back the viscera or catching the final oozing from the abdominal walls when the wound is closed; three (and only three) small, firm probang-sponges in Sims's sponge-holders. Only one person (a nurse preferably to a medical assistant) should ever be allowed to touch the sponges; she must always count them before the operation, and again before the abdominal wound is closed. For an hour before the operation they are to be soaked in a hot carbolic solution, 1–50; and after the operation they are to be carefully and frequently washed in a solution of carbonate of sodium and ammonia, again in the strong carbolic-acid solution (never in the bichloride, which rots them), and then carefully dried and kept in air-tight jars. In this way good sponges may be kept for three months as good as new, and absolutely free from infectious elements. Beside the nurses (or nurse) four competent and cool assistants are needed: one to give ether, which he is never to leave or transfer to another; one to assist the operator with the tumor and abdominal viscera; one to hand and take back the instruments, which are constantly immersed in carbolic-acid solution, 1–40 (not bichloride, which rusts them, and ruins the knives); and one to attend to the cautery if it be required. More than this number are embarrassing, and are often in each other's way. If other spectators be present, they should be kept at a distance from the operating table. The English custom of obliging all visitors to sign a statement that they have not recently come from cases of contagious disease, or from the dissecting-room, is wise, and should be always followed in this country.

The several stages of an ordinary ovariotomy are: (1) Incising the abdominal wall and peritoneum; (2) Evacuating the contents of the tumor; (3) Extraction, or "delivery," of the sac or tumor; (4) Treatment of the pedicle; (5) Treatment of adhesions and other points of bleeding; (6) The so-called "peritoneal toilet;" (7) Closure of wound, with or without drainage; (8) Application of antiseptic dressing.

(1) In all cases of laparotomy, it is well to regard the *abdominal section* as a temporary "explorative incision;" and therefore, except in the predeter-

mined removal of large solid tumors, this should at first be short, and afterwards enlarged.

There is no doubt that in cases of short explorative incision the ratio of recoveries is greatest, whatever be the fact in completed ovariotomies. In the latter, the forcible traction and other efforts to deliver a sac, which may contain more or less of solid matter, through a short incision, is fraught with more risk than a much larger section of the abdominal wall. Sir Spencer Wells's statistics show that no diminution of mortality follows the shortening of the incision below five inches, but that a higher death-rate always occurs when it exceeds six or six and a half inches. It is proper to begin, then, with a section three inches long (to be extended to five or six), in the median line, midway between the umbilicus and the symphysis pubis. This should pass boldly through skin and fat down to the linea alba; if the latter be missed, and the rectus muscle cut into, a probe must be pushed under the sheath towards the middle line until the linea alba is found, when the dissection is at once continued. The transversalis fascia is raised and cut on the director, and the extra-peritoneal fat is lightly divided down to the peritoneum. This is smooth, shining, and usually translucent, with the sac or intestines visible through it. Before proceeding further, all bleeding, which has until now been restrained by sponging, is to be securely checked with compression-forceps, of which four or five may have to be applied at once; and the bottom of the incision is also to be made even with that in the skin, unless (as should be done) this equality has been preserved from the first. The peritoneum is now to be caught up with a tenaculum, or forceps, opened obliquely with scissors, and then freely divided to the extremities of the incision with scissors upon a broad grooved director. The latter is invaluable for this purpose, as its smooth convex back pushes away adhesions and loops of intestine without injury. Should vessels bleed in the peritoneal incision, they are at once caught up with compression-forceps and ligatured with catgut; ligatures on the vessels in the parietes or rectus muscle are best dispensed with.

The glistening wall of the cyst is now exposed. The hand is then rinsed in carbolic or bichloride solution, and two fingers are gently passed around the cyst—if possible, into the pelvis, to ascertain its uterine connection. If no adhesions exist in front, a steel sound or "searcher" is carefully passed around the tumor, and its base is examined.

If, for any reason, it be thought impossible to proceed, the tumor is not further disturbed; a thin flat sponge is then introduced and held with forceps under the line of the wound, and upon this the peritoneum is closed with a catgut overstitch, which is tightened as the sponge is withdrawn, and the short abdominal wound is then closed. This will have been an explorative incision. If the tumor be removable, the adhesions are broken up with the sound as far as possible, and the surgeon passes at once to the second stage.

(2) For the purpose of *evacuating the contents of the cyst*, various plans and appliances have been in vogue.

Sir Spencer Wells employs an elaborate trocar with an attachment of rubber tubing to carry off the fluid; Dr. Keith prefers a large aspirator which works rapidly; Mr. Tait uses a trocar which is simply a modification of Wells's; and many German operators simply cut in with a bistoury, and empty the sac by lateral pressure with the hands.

In New York, almost every one uses the Emmet trocar,[1] which is simple, cleanly, and admirably efficient; one of large and one of small size should be at hand. The patient is gently turned on her side, facing the operator, as originally suggested by Sir Spencer Wells; the trocar is thrust into the most available point of the cyst; and the contents are emptied through the canula into a common washtub under the operating table. As the fluid pours out, an assistant steadies the abdominal walls with gradually increasing lateral pressure; and, as soon the cyst grows flaccid, the operator inserts a large tenaculum or hook just beyond the canula, and, with this or with Nélaton's sac-forceps, makes enough traction to cause it to bulge or protrude from the wound. Either now, or previously if there has been evident need, the external wound is enlarged a full inch upwards and downwards: this is best and most quickly done with stout scissors upon two fingers of the left hand as a guide, and, if new vessels bleed, compression-forceps are again supplied.

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[1] Emmet, op. cit., p. 728; Thomas, op. cit., p. 737.

The sac being now moderately drawn out, the canula is removed, and a free incision is made with scissors through the protruding part. In this way it is emptied far more expeditiously; or, if the flow ceases while the mass of the cyst remains imprisoned within the abdomen, the right hand is to be passed gently into the cyst-cavity, and, if secondary cysts be felt, they are broken down and their contents rapidly discharged. All this time the most watchful care is needed to prevent any of the fluid from escaping into the peritoneal cavity, which it will surely do unless the operator be intelligently aided by the assistant who is keeping up abdominal pressure. As Dr. Thomas urges, it is most important to abstain from passing the hand into the peritoneal cavity during this or the following stage of the operation, both because septic matter is often thus conveyed to the peritoneum, and because the manipulation of the sac can as easily be effected from its interior. If, instead of thin fluid, the sac-contents prove to be a colloid material, this is to be gently scooped out with the hand inside the sac, while the extremities of the incision are held on the stretch by the large tenaculum-hooks.

(3) *Extraction of the sac* is now effected, either easily or with much complicated difficulty, in accordance with the number and character of the adhesions. If these be few or trifling in character, simple traction with the Nélaton forceps suffices to overcome them; two pairs of forceps are used, and their successive application soon delivers the entire sac through the abdominal wound and brings the pedicle into view. Even dense and rather vascular adhesions are best separated in this manner. But if the base of the tumor be extremely adherent to the pelvic walls or the uterus, or if intimate intestinal adhesions exist, this will not answer. In the latter case, patient separation must be effected with the edge and handle of the scalpel, checking all bleeding points by torsion or catgut ligature; in the former, an effort must be made to "enucleate" the cyst, as suggested by Miner,[1] of Buffalo. This means to split or separate the layers of the cyst so effectually as to isolate and remove the tumor, while leaving the outer layer, with the bloodvessels that cover its surface. Where there is no pedicle, this method is sometimes applicable.

(4) The *pedicle* being now exposed, we have to choose between three methods of dealing with it: the ligature, the clamp, and the cautery.

In this country the *cautery* is rarely used, although with it as a constant reliance, Dr. Keith, of Edinburgh, has obtained the best results thus far recorded in the practice of ovariotomy. Either Paquelin's or the actual cautery may be used, and with one of these at a dull red-heat, the pedicle is to be slowly burned through on an ivory or iron cautery-shield. After this the surface of the pedicle is again cleansed, rubbed with persulphate or perchloride of iron, gently wiped off, and cautiously returned to the cavity of the pelvis.

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[1] Buffalo Med. and Surg. Journal, June, 1869.

The *clamp* is suitable only for long pedicles with much vascular and tough fibrous tissue, and is as rarely used here in ovariotomy as it is commonly in hysterectomy.

The *ligature*, cut short, with return of the pedicle to the abdominal cavity, is the plan preferred by most American operators, and in their hands has given uniformly the best result. The ligature used may be either thin carbolized Chinese silk, No. 3 or 4, or Turner's braided silk of heavy quality. With this a blunt artery-needle is threaded, and carried with some force through the middle of the pedicle, as low down as practicable. The ligature may now be either so cut as to be double—in which case it is firmly tied in a double knot in a figure-of-eight, after crossing the two silks—or the two halves of the pedicle may be successively secured by a single ligature, which is tied strongly on one side, and then reversed and tied similarly on the other. Then the pedicle is seized with a compression-forceps (Sims's preferred) on each side, just below the ligature; the cyst is cut away a half inch above it; the cut surface is carefully examined to see if any oozing occurs; if all seems secure, the ligature is cut short and the pedicle is dropped into the pelvic cavity. Should the pedicle be unusually thick and vascular, it may still be ligated as above, but in three portions instead of in two. The other ovary should then be examined, and, if cystic, should be removed.

(5) The *management of adhesions* is often a source of difficulty and of great embarrassment. If long and vascular, they may easily be ligated at two points and divided with scissors between. But when short and dense, and connected with important organs, like the bladder, intestines, liver, or stomach, they can only be separated with extreme difficulty. This is best done with the handle of a scalpel, using the blade as little as possible, and if more bleeding occurs than is easily arrested by torsion, ligatures of catgut or fine Chinese silk must be used freely. When bleeding occurs deep in the pelvis it is very embarrassing from want of light; but this can now be supplied by the small portable electric light, which is extremely serviceable as long as it can be kept in order. If adhesions are inseparable from the tumor, as sometimes happens, a small piece of the cyst-wall may be cautiously cut out and left with its attachment, after cauterizing its edge with strong carbolic acid, or with the actual cautery; the secreting membrane or face of the cyst-remnant should be removed.

(6) The *peritoneal toilet* is a convenient and expressive term originating in Germany, to indicate the scrupulous cleanliness and finish in which the peritoneal surface must be left. We owe this care, perhaps, more to Dr. Keith, of Edinburgh, than to any other writer; and it is the means of saving many lives which would otherwise be lost. The cardinal points are that no bleeding points, however small, must be left, and that the entire peritoneal surface must be left perfectly dry. For this purpose it is all to be gone over with fresh sponges and ligatures, with the utmost care, just before closing the abdominal wound. In doing this the large sponges are used to push back the intestines.

(7) In *closing the abdominal wound*, these flat sponges again come into use. One is laid upon the viscera just under the line of the wound, a Sims's forceps being attached to its upper and one to its lower edge; over this the peritoneum is sewed up with catgut sutures as already described, the sponge being gently drawn out just before the stitches are tightened. It will often be saturated with bloody serum, although it was perfectly wrung out and dry before it was placed in the abdomen. Two silver sutures, one at either end of the wound—or three if the wound has been a long one—should be carried through the entire thickness of the abdominal wall and the peritoneum, before the sponge is removed. All the sponges and forceps are now to be

carefully counted, and the wound is to remain unclosed until all are found; then, with interrupted sutures of Chinese silk, or of silver wire, the rest of the wound is closed down to the peritoneum only.

The question of *drainage* will depend entirely upon the thoroughness with which oozing from the peritoneum and adhesions has been arrested, and the probability of its return. If the latter be apprehended, or if enucleation, or any modification of it have been practised, it will be wiser to leave a drainage-tube in the lower angle of the wound. This may be of glass or hard rubber, and either Keith's, Thomas's, or H. Marion Sims's, may be used as preferred. The two latter have the advantage of being double-barrelled, so that a continuous stream can be forced through them. This may be carbolized, or mixed with "Listerine," or other disinfectants, at pleasure. The pelvic cavity should be thus washed out whenever the pulse or temperature runs up without adequate cause.

(8) The abdominal wound is *dressed* in as nearly perfect an antiseptic and Listerian manner as possible. The line of incision is sprinkled with dry iodoform; over this is placed a narrow strip of "protective" oiled-silk, and then two or three strips of rubber adhesive plaster, extending from under the hips on each side to take the strain off the sutures; over this is laid a treble thickness of iodoform gauze, and over all a layer of salicylic cotton, sufficiently thick to fill up all inequalities of the abdominal surface, and to produce slight, equable pressure. This is kept in place by a well-fitting muslin bandage; and, if possible, the dressing is not to be disturbed until the fifth day; if there be no uneasiness, not until the eighth or ninth day.

In the *after-treatment*, the great object is to secure rest and reasonable freedom from pain, and to prevent high grades of peritonitis. To effect this the stomach is kept empty for thirty-six hours, and then small quantities of hot water are given, and followed by milk and lime-water, and other light liquid food. Morphia is given hypodermically as required.

The *complications* to be apprehended after ovariotomy are, in order of time, secondary hemorrhage, peritonitis, and septicæmia; but, in point of frequency and importance, this order should probably be reversed. If unmistakable indications of *secondary hemorrhage* occur, there is no resource but to reopen the wound after giving a small amount of ether; and, if possible, to secure the bleeding points with ligatures. Desperate as this measure is, it is better than to let the patient die without making an intelligent effort to save her life. *Peritonitis* is to be combated by increased doses of morphia, hypodermically or by the rectum, and, in the formative stage, by external refrigeration. The latter is applied either by means of the douche and Kilbee's cot, as recommended by Thomas, or by the ice-cap of block-tin pipe and the abdominal coil of rubber-tubing; of these the latter is much the more manageable. In *septicæmia*, the drainage-tube is to be used at once, if possible, with antiseptic injections; and stimulants, and well-selected and nutritious food, must be given freely.

The *contra-indications* to ovariotomy are malignant disease, acute disease (inflammatory) of the organs of the chest and of the kidneys—but not chronic inflammations, unless very far advanced—and, in a more limited sense, universal adhesions between the cyst and other organs. Pregnancy is not a barrier; and I have elsewhere[1] given the reasons why, if the condition of the cyst be such as to demand operation, ovariotomy should immediately be resorted to. In 1880, Sir Spencer Wells had operated in nine cases complicated with pregnancy, with eight recoveries; in five the pregnancy continued to full term, in three miscarriage occurred. Mr. Lawson Tait, in 1882, wrote that he had had eleven such cases with ten recoveries, and that the fatal case was, he thought, due to his mistaken treatment of the pedicle with a clamp. I have myself operated in three such cases, with one death which occurred in a case complicated by malignant disease. Many others are upon record, especially in Germany.

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[1] Trans. Amer. Gyn. Soc., vol. viii. p. 158 *et seq.*

OÖPHORECTOMY ; BATTEY'S OPERATION.—This operation, which has also been called normal ovariotomy, spaying, and female castration (*castration der frauen*), consists in the extirpation of ovaries, which, although diseased, are not necessarily enlarged.

It was first intelligently proposed as a remedial measure by Dr. James Blundell, who, in June, 1823, laid before the Royal Medical and Chirurgical Society of London[1] a memoir in which he suggested extirpation of the ovaries for the relief of intolerable dysmenorrhœa, and to arrest recurrent hemorrhage in cases of inversion of the uterus. He did not, however, attempt it in practice, and the proposition was forgotten. In 1872, Hegar, of Freiburg, and Dr. Robert Battey, of Rome, Georgia, almost simultaneously removed the ovaries for the cure of analogous conditions of disease—Hegar for intense ovarian neuralgia, Battey for insufferable dysmenorrhœa. Hegar's patient died, and the case was not published ; Battey's recovered, and an account of his operation appeared, with the author's views and reasons for its performance, in the Medical and Surgical Journal of Atlanta, Ga., September, 1872, thus securing him priority in suggesting this measure to the profession.

Mr. Lawson Tait says[2] that a year previously, in 1871, he had come to the same decision under similar circumstances, and had operated in furtherance of this view in February, 1872. As his case did not see the light until 1873, it has not affected the claim of Dr. Battey, who will always be recognized by the profession as the practical author of the operation.

Believing that ovulation was the cause of menstruation, Dr. Battey proposed the removal of the ovaries to anticipate and force the menopause, and chiefly in cases of dysmenorrhœa, or of mental and nervous disturbances caused by dysmenorrhœa. Prof. Hegar has assiduously pursued the subject with a different object, the checking of menstruation and metrorrhagia in cases of uterine fibroids. Of Mr. Tait's special views mention will be made in the next section.

The indications for Battey's operation are: (1) Excessive and uncontrollable dysmenorrhœa; (2) Excessive menorrhagia or metrorrhagia; (3) Increasing menorrhagia with uterine fibroids: (4) Hystero-epilepsy, and allied conditions; (5) Prolapsed ovaries and intractable ovaritis; (6) Recurrent perimetritis with dysmenorrhœa ; (7) Ovarian irritation with absence of uterus and vagina. It will at once be seen that these indications include two main groups : 1. Neurotic conditions from ovarian irritation. 2. Hemorrhage with, or without, uterine tumors. Dr. Battey and his immediate followers have chiefly had in view the relief of the first group of cases. Trenholme and Hegar, and the latter's followers in Germany and Great Britain, have operated mainly for the relief of the second.

Operation.—As in ovariotomy, two methods are in vogue for performing extirpation of the ovaries, viz: 1. Vaginal extirpation, or elytrotomy ; 2. Abdominal extirpation, or laparotomy.

1. The *vaginal method* has been recommended in cases where the ovaries are prolapsed and movable in the *cul-de-sac*, and is thus performed :—

Etherize the patient and place her in Sims's semi-prone position, or in the lithotomy posture. Use Battey's or Sims's speculum; wash out the vagina with an antiseptic solution; draw down the cervix with volsella forceps, and keep it fixed at or near the vulva. Divide the posterior vaginal wall behind the cervix for an inch and a half in the middle line. Work cautiously through this opening into the peritoneal cavity; hook down the nearest ovary with the index finger, if possible, while counter-pressure is made over the pubes; transfix the hilus of the ovary with a stout needle carrying a thread of fine carbolized silk, tie this firmly around each half in succession, cut away the distal part of the ovary, and return the stump with close-cut ligature to the pelvic cavity. Repeat this proceeding on the other side; then pass in a drainage-tube and stitch up the wound around the tube with catgut, or, if preferred, leave it open to granulate. Wash out the vagina twice daily with solutions of listerine or weak carbolic acid. Instead of excision and permanent ligature, Dr. Battey used the écraseur with a temporary ligature around the base.

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[1] Aveling, Obstet. Journ. of Great Britain and Ireland, vol. vi. p. 617.

[2] Disease of the Ovaries, American edition, pp. 323 and 326. 1883.

From the above description the operation would appear to be a simple one, but in a number of cases it has proved so difficult that it has been abandoned, and laparotomy done instead.

2. The *abdominal section*, or *laparotomy*, is similar to an ordinary ovariotomy, until the peritoneum is reached. This membrane is much more difficult to manipulate than in ovariotomy, partly because it has undergone no inflammatory thickening, and partly because the intestines lie directly under it, and, if distended with flatus, rise constantly into the abdominal wound. The operator now bathes his hands in some disinfectant, passes two fingers into the pelvis, touches the fundus uteri and slides the finger along this and the ovarian tube until he reaches the ovary of one side, which generally lies behind the Fallopian tube. Hooking up the ovary gently with two fingers, and, if at all possible, without tearing it, he brings the ovary up until it points in the wound. Then, with a blunt artery needle, he carries a ligature of Chinese silk through the hilus, and ties it very firmly in a double knot with reverse. He now catches the attachment just below the knot, and, if the ligature is satisfactory, cuts away the ovary a quarter inch above the knot. He cauterizes the cut surface with Paquelin's cautery if it seems vascular and likely to ooze; but if not, cuts the ligatures short and drops the ovarian stump back into the pelvis. He repeats the same procedure with as little change as possible on the other side, cleans out the peritoneal cavity most carefully with sponges wrung out in the hot carbolic solution, and closes the abdominal incision.

To prevent oozing of blood into the pelvis at this stage, a large flat sponge, also wrung out in the hot carbolic solution, is used, to be kept under the line of the wound; this (guarded with long compression-forceps at each end) remains until all the sutures are inserted, and is removed just before they are tightened. All sponges and forceps are now counted, as in other abdominal sections. The peritoneal incision is closed separately with catgut or silkworm-gut sutures; for the outer tissues, Chinese silk or silver wire is best. The wound is dressed as after ovariotomy. All the antiseptic precautions enjoined for the latter operation must be used.

In conclusion, it may be said that Battey's operation is more difficult than an ordinary ovariotomy, and that the subsequent risks of peritonitis are greater. To an operator unaccustomed to abdominal surgery it is peculiarly trying; but with patience and gentleness of manipulation the ovaries can generally be detached from their bed and brought up sufficiently high for safe ligation. When the operation is attempted for the relief of bleeding fibroids, the tumor and uterus must be tilted over to each side successively, before the underlying ovary is disturbed. For this a longer abdominal incision—at least of five or six inches—is necessary. In a large minority of these cases the ovary and tube are closely adherent to the tumor; under these circumstances the surgeon should consider the propriety of hysterectomy as a substitute.

As to the clinical importance of Battey's operation, it may be said to be still *sub judice;* but, in properly selected cases, each year's experience shows its greater value, which is far higher to-day than when five years ago Mundé[1] and Thomas[2] summed up its merits.

Extirpation of Uterine Appendages; Tait's Operation.—Mr. Lawson Tait, of Birmingham, has from the beginning contended that it is far more important, in all the cases for which Battey's operation is recommended, to remove the Fallopian tubes than the ovaries; but that, for convenience of manipulation, it is best to remove both. This is because the tubes have more to do with the function of menstruation, while the ovary is physiologically concerned with ovulation only. For twelve or fifteen years he has consistently followed in practice the conclusions that flow from these premises.

His procedure, known as "*Tait's operation*," is precisely the same as that last described, with one exception: instead of ligating and cutting away the ovary alone, he passes the ligature in the form known as "the Staffordshire knot" so as to penetrate the broad ligament nearer the uterus, thus including both the tube and ovary. When the ligature is secured these are cut away "*en masse*," the tube being first carefully aspirated if hydrosalpinx or pyosalpinx seems to exist.

The subsequent steps of the operation are the same, except that in Mr. Tait's practice "Listerism" has no existence, scrupulous cleanliness and general antisepsis taking its place.

This modification of the "Battey operation" is now generally adopted in New York. For the detail of Mr. Tait's views and procedure, couched in much crispness of expression and pleasantly discursive writing, the reader is referred to his volume on "Diseases of the Ovaries," 1883, which is an amplification of his well-known "Hastings Essay," of 1873.

Hysterectomy.—In describing the surgical treatment of uterine cancer reference has been made to hysterectomy, both by the vagina and by Freund's abdominal method.

Vaginal Hysterectomy.—This operation is performed as follows:—

1. Drag the cervix firmly down to the vulva with Museux's forceps, incise the vagina in front of the cervix, and separate the bladder carefully from it, without opening the peritoneum. If quite healthy, this is done with the bistoury; if at all diseased, with the galvano-cautery. . Free the cervix posteriorly in the same manner.
2. Cut into Douglas's space and pass two fingers of the left hand through it, over the fundus, down into the utero-vesical pouch. Upon these, as a guide, divide the peritoneum cautiously with blunt scissors, and separate the uterus from all its attachments except the broad ligaments.
3. Now retrovert the womb, and bring it down, if possible, through the posterior vaginal incision; this is not easy, but may be effected by grasping it near the fundus with stout volsella forceps. If the vagina be small, or the uterus very large, or hard, or if a complicating fibroid be in the way (as in a case which I once saw), this step is extremely difficult.
4. Transfix the broad ligament on one side with a blunt (aneurism) needle carrying a stout braided silk ligature, tie it in two parts, and put a separate ligature around the whole; divide each section with scissors, and, when the

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[1] Archives of Medicine, Feb. 1880.

[2] Op. cit., p. 757.

uterus is completely freed, repeat the same process on the other side. The difficulty and the risk of hemorrhage here are greatly increased, if ablation of the ovaries and tubes is attempted. If apparently healthy, they should be left.

5. Cut away the uterus and examine the pedicles carefully; when all bleeding has ceased, close the peritoneal wound with catgut sutures, and fasten the pedicles into the line of closure by a silk or wire suture, a rubber drainage-tube being passed through the centre and maintained by the vaginal dressing. Through this the pelvic cavity may be washed out if the temperature rises, or if the discharges become offensive.

6. Pack the vagina lightly with aseptic gauze; remove this in from three to six days, and the sutures in a fortnight. The results of this operation are as follows:[1] up to January 1, 1884, there had been performed at the Berlin Institute, for carcinoma, 35 vaginal hysterectomies; of these 9 ended fatally; the result was unknown in 6; relapses within two years had occurred in 15; the patients had remained free from disease for two years or longer in 5. The student may also consult, with much advantage, two exhaustive papers on this subject by Dr. Ch. Fenger, of Chicago, in the Am. Journal of Med. Sciences, Jan. 1882; and by Dr. P. F. Mundé, in the Trans. of the Amer. Gyn. Society, vol. ix. p. 195. The latter author tabulates a series of 255 cases in this country and Europe, with a mortality of 72, or 28.23 per cent. Each year this ratio is diminishing.

Extirpation of Uterus by Abdominal Section.—This procedure was devised and published by Dr. Freund,[2] of Strasbourg, in 1876, and seemed at first destined to have a brilliant future, but in the ten years during which it has been before the profession it has steadily waned in popularity, and in this country it is rarely performed. The steps are as follows:—

1. An abdominal incision is made in the median line, as for ovariotomy, but extending to the symphysis pubis. The recti muscles may be partially divided near their pubic insertion, if the abdominal walls are very tense. When the peritoneum is opened, the intestines are drawn up, and, if necessary, are brought out and covered with hot carbolized cloths; the uterus is caught with stout forceps and is drawn forcibly up from the pelvis. Thus the vagina and all the uterine connections may be kept on the stretch.

2. The uterus is now dragged to one side and the opposite broad ligament is securely tied by a double ligature of braided silk, so passed on a blunt needle as to include, successively, the Fallopian tube, the ovarian artery, and the round ligament, thus controlling the pampiniform plexus of vessels. The womb is now tilted to the other side and the same process is repeated; the stout ligatures are left long, and are firmly held by assistants. Another ligature is now passed through the fornix vaginæ, to control the uterine arteries; and very little of the vaginal tissue must be included in this loop, or the artery will not be compressed.

3. The bladder is next carefully separated from the womb with the nail and scalpel-handle, a sound being kept in the organ meanwhile. The uterus may now be cut away, a wedge-shaped piece being cut out of the cervix; the cut edges of the cervical stump are finally sewed together by deep sutures, and the peritoneum is carefully brought together around it; all bleeding points are carefully secured, the pelvis is minutely cleansed, the intestines are returned, and the abdominal wound is closed as after ovariotomy. A drainage-tube should always be used.

If it be desired to remove the entire cervix, the vaginal wall is opened from below and dissected from it, as described in speaking of the vaginal operation, only more rapidly. Before closing the vaginal vault, the long ligatures are brought out through this opening into the vagina.

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[1] Amer. Journ. of Obstet., Feb. 1886, p. 208.

[2] Samml. klin. Vorträge, No. 133; Centralbl. f. Gyn., No. 12, 1878.

The results of this form of hysterectomy have not been good in this country; and in Germany, where it has been mainly done, Hegar and Kaltenbach state that of 89 completed operations only 26 ended in recovery; the mortality was therefore 71 per cent. The chief causes of death are shock, peritonitis, and secondary hemorrhage.

Freund's operation has thus been so fatal, that, among careful and conscientious surgeons, it is, already, practically a thing of the past. But the application of his method, or of some modification of it, to the treatment of myomata or uterine fibroids, has suggested itself to the more active observers in every country.

In Germany, Schroeder, Hegar, Olshausen; in England, Bantock, Thornton, Spencer Wells, Tait; Keith in Scotland, and a number of writers in this country, have recorded their views and experience; so that to-day the procedure is well recognized and understood in its technique, however doubtful be the conditions that justify its performance.

To illustrate that uncertainty, two facts only need be stated: (1) Uterine fibroids, for which hysterectomy is mainly performed, are not necessarily fatal like ovarian cysts; in fact, they cause death with extreme rarity. (2) The aggregate mortality, even among the most skilful and experienced operators, is still more than 33 per cent., a serious matter to contemplate in an operation of election only.

In March, 1884, Dr. H. R. Bigelow, of Washington, published in the American Journal of Obstetrics the statistical results of all known operations of hysterectomy, which then showed a mortality of over 33 per cent. Thus in 359 completed operations there were 227 recoveries, and 132 deaths. The full table, with the details of each reporting surgeon's experience, is given by Emmet.[1]

Those who may wish to consult detailed monographs on the subject are referred to Hegar and Kaltenbach's "Operative Gynäkologie," 1881; Schroeder's paper "on myomotomy" in the British Medical Journal, Oct. 13, 1883; Mr. Knowsley Thornton's views on the "operative treatment of fibromyomata" in the same journal; and, lastly, a notable and most important memoir by Dr. Thomas Keith on "hysterectomy for fibrous tumors of the uterus," published in 1885.

In the latter work, which is replete with valuable hints and wise suggestions, its distinguished author repudiates the idea which is often expressed that hysterectomy "is in much the same position now that ovariotomy was five and twenty years ago," because of the essential difference in the danger to life of uterine fibroids and ovarian cysts. After a condensed consideration of these tumors, he admits that the following are conditions in which hysterectomy "may reasonably be advised:"—

1. In very large, rapidly growing tumors of all kinds, in young women. By a large tumor is meant a tumor of upwards of twenty pounds.
2. In all cases of real fibrous-cystic tumors, if they can be removed. Also in all cases of suppurating tumor.
3. In most cases of soft œdematous fibrous tumor. These often grow to an enormous size, far larger often than any ovarian tumor.
4. In cases of large bleeding fibroids of any age, provided that the patient is not approaching fifty years of age, that her life is practically useless, and that further experience in the operation shall show that the mortality of hysterectomy is likely to diminish.

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[1] Op. cit., p. 617.

5. In certain cases of tumors surrounded by free fluid, the result of peritonitis, provided that the fluid shows a tendency to reaccumulate after two or three punctures.

These (says Dr. Keith) embrace every form of case in which I have yet ventured to interfere by operation.

The ordinary operation of hysterectomy (as distinguished from Hegar's method) is performed as follows:—

The patient being etherized and recumbent, and the usual antiseptic precautions taken, an incision is made in the median line of the abdomen as for ovariotomy. But this incision must be much longer than in the latter case —from six to ten inches at once. The peritoneum being divided, the adhesions around the tumor, which nearly always exist, are to be quickly examined, and those which are densest and offer most resistance to the mobility of the tumor are grasped with stout long clamp-forceps, and divided at once on the distal side; the tumor is then rotated and drawn up, if possible, through the abdominal wound. At this point it will often be necessary to enlarge the latter to fully twelve or fourteen inches; nor need there be any scruple in this, for no clinical evidence shows that long incisions retard recovery, if their closure be equable and complete. As the tumor is raised, or extracted through the abdominal wound, its connection with the bladder must be carefully examined. This can easily be detected if, contrary to the usual rule, the bladder be left full of urine before ether is given. In an instructive case narrated by Emmet,[1] this sagacious departure from established custom probably saved him from the misfortune of cutting into the bladder, which has often befallen others. If adherent, the bladder is rapidly separated, and the broad ligaments and their contents are ligatured as far from the uterus as possible, with two stout ligatures, and divided between the two points. If tightly adherent to the tumor, they should not be dissected off but removed with it above the clamp. Then, dealing with the posterior pelvic adhesions as with those first described, a temporary clamp, or Kœberlé's serre-nœud, or an elastic ligature, is made to constrict the base of the tumor, and the mass above it is rapidly cut away. The adhesions must now at once be attended to. They are all inspected carefully in succession; fresh ligatures of catgut or Chinese silk are applied where necessary; the clamp-forceps are cautiously removed and the bleeding points within their grasp tied with more ligatures; the entire cavity of abdomen and pelvis is thoroughly sponged and cleansed, and then the permanent clamp[2] is applied to the pedicle. If possible, this should go just below the temporary clamp or ligature, and yet not so far down as to make undue traction when placed outside the abdominal wound. The surgeon shaves down the pedicle to within a quarter of an inch of the clamp; burns or "cooks" the surface thoroughly with the actual cautery (Paquelin's); if there be any cause to apprehend the slipping of the pedicle through the clamp, thrusts two long steel pins (as advised by Thomas) through the pedicle obliquely just above the clamp; examines the pelvis once more for oozing bloodvessels; and, if all seems dry, closes the abdominal wound at once. This is done as in ovariotomy, the flat sponge being kept under until the sutures are *in situ*, the peritoneum closed separately with catgut, and the walls with silver wire or Chinese silk; the sutures should be numerous, about four to the inch, and must include the entire thickness of the walls. The dressings are the same as after ovariotomy. The clamp usually becomes loosened about the seventh or eighth day, and the patient sits up in bed at the end of two weeks.

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[1] Op. cit., p. 612.

[2] Dawson's or Thomas's clamp is employed in New York. I prefer the former, but both are excellent.

It need only be added that, after this operation, the clamp is found in this country and in England to be as uniformly useful as it is harmful in ovariotomy; while no proportionate amount of success has attended any intra-peritoneal method of treating the pedicle.

In Germany, however, Prof. Schroeder has succeeded well with ligation of the pedicle, covering it in with the peritoneum.

Prof. Hegar, of Freiburg, whose success in hysterectomy for myomata has only been surpassed or equalled by Keith, treats the pedicle by a special method. He surrounds its base, as low down as possible, with Kleeburg's elastic ligature, which is tied while on the stretch. Above this a double ligature is passed through the stump, tied firmly in two sections, and all above that cut away. Now, drawing up the stump into the lower angle of the abdominal wound, the parietal peritoneum is stitched securely to the peritoneal covering of the pedicle, just below the elastic ligature. The first suture above the stump is passed through the parietal peritoneum, then under the elastic ligature and through the peritoneum on the opposite side; and when this is tightened it closes in the stump with peritoneum completely. Two more sutures are passed just above this through the peritoneum only, and the rest of the wound is closed as usual. The face of the stump is now cauterized; the raw surface around it is painted freely with a strong solution of chloride of zinc, and packed lightly with aseptic cotton, which is frequently changed as it becomes saturated with discharge; and the whole is covered lightly with the usual antiseptic dressing, constant watchfulness preventing the collection or burrowing of pus. About the tenth day the elastic ligature is carefully cut away, and good union is obtained in a fortnight.

INFLAMMATORY AFFECTIONS OF THE BONES.

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THE bones were long considered as a separate system in regard to pathological alterations. It is only during the last fifty years that it has been well understood that their lesions are analogous to those of the soft parts, and that their pathological processes are developed in the same manner and lead to the same results. Experimentation on the one hand, and histological researches on the other, have finally established this analogy, which pathological anatomy had already demonstrated to Gerdy, to Cruveilhier, and to other authors who wrote in the first half of this century.

The ancients designated under the name of *caries* most of the alterations of the bones; at the end of the last century they distinguished *necrosis*, but in the first third of this century the greatest confusion still reigned in regard to inflammations of the bones; Boyer described only caries and necrosis, and, although speaking in a number of passages of inflammation of the periosteum and bones, it did not occur to him to give a special description of this inflammation. It was not until 1835, at the time when Gerdy created the word *osteitis* to designate inflammation of the bones, that a clearer idea arose as to the various alterations of which bone-tissue is susceptible. From this moment numerous works appeared on all sides upon the affections of the bones; and among the most important must be mentioned, at the outset, those of Chassaignac, of Nélaton, of Gosselin, of Klose, of Roser, of Volkmann, of Stanley, of Paget, of Ranvier, and of Lannelongue.

It is not possible, in this article, to dwell upon historical questions, and yet it should not be ignored that, even in the last century, notwithstanding the silence of Boyer and of the classical authors who followed him, there are found very important documents bearing upon the history of our art, which show that affections of the bones had already been considered at that epoch with much justness and profundity. Boerhaave and Van Swieten advanced propositions which appeared novel a century later. The first aphorism of Boerhaave bears upon the analogy of diseases of the bones with diseases of the soft parts. Inflammations of the periosteum and of the medullary tissue are afterwards not only mentioned but exactly outlined. The cause of the gravity of inflammations of the medulla is found, according to these authors, in putridity of the medullary tissue—a putridity which they explain by the presence of fat and by the chemical properties of this tissue. As a corollary to these propositions, free incisions of the periosteum and trephining of the medullary canal are formally recommended, and antiseptic indications are clearly formulated.[1] In this work of doctrinal exposition and of criticism, which is very remarkable for the times, Van Swieten describes inflammation of the external periosteum and of the internal periosteum or marrow. He insists upon the lesser gravity of inflammation of the external periosteum, and dwells at length upon the infection produced by corruption of the medullary oil. This infection, starting from the marrow, passes through the bones, reaches the periosteum, and then infects it and spreads through the tissues of the members. Hence the need for very energetic treatment to arrest this medullary corruption and the infection which is its consequence. There is doubtless much which is vague in some of these descriptions, but it has appeared to me of interest to refer to these theories which, expressed in more modern style, are no different from those by which we are guided to-day. It is also interesting to recall the boldness of certain therapeutic precepts which we are very apt to consider new, and which are explicitly formulated in books which were classic a hundred years ago. But these precepts were rarely put into practice, and unfortunately remained as a dead letter to the majority of surgeons.

In this article I purpose to study inflammations of the bones in general, dwelling especially upon acute and spontaneous inflammations, since traumatic inflammations have been already studied[2] in connection with fractures, and since chronic inflammations will receive fuller treatment in the article devoted to scrofulous and tuberculous bone-lesions. Nevertheless, I shall examine the different forms of chronic osteitis, and I shall give some space to the chronic lesions which are the consequence and sequel of acute osteitis. In connection with this I shall take up questions heretofore little studied, such as the influence of osteitis upon the growth of the bones, and the remote consequences of acute inflammations occurring in infancy and adolescence.

One of the most important matters to bear in mind in the study of inflammation of bone, is the influence of age; these affections are so linked to the development of the skeleton that they differ entirely in infancy and in mature life. The study of the development of the bones throws special light upon these affections, and explains their character, their course, and their termination in a multitude of circumstances. It enables us to understand their seat of election in different parts of the bone, and explains their frequency in different bones or in different parts of the same bone. Therefore we should always remember the close relation which exists between the physiological processes of growth and the various pathological processes. This notion is indispensable to the interpretation of diseases of the bones; by it everything is set in order and simplified.

EFFECTS OF IRRITATION ON THE VARIOUS CONSTITUENTS OF BONES.

Bone is made up of three different tissues which enter into its structure to a greater or less extent, according to the age of the subject and according to the different regions. The periosteum, the bone-substance proper, and the marrow, are the constituent parts of bone. To these three tissues should be added a fourth, cartilage, which no longer exists, or at least exists only in the state of a terminal layer, in the bone of the adult, but which, in the first period of life, plays a predominant part in the formation of bone-tissue. These tissues have different physiological functions, and are of unequal importance in regard to pathological processes. They are more exposed to inflammation as they are more vascular, and formed of a greater quantity of soft elements and young cells.

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[1] Hermann Boerhaave, Aphorismes de Chirurgie, commentés par Van Swieten, t. v. (Des maladies des os.)

[2] See Article on Injuries of the Bones. Vol. IV., page 1, *supra*.

The presence of vessels in a tissue is not an indispensable condition in order that it shall undergo inflammatory changes, as was formerly believed, when the characteristic feature of inflammation was looked for especially in the modifications of the vascular system. The articular cartilages go through the first stages of inflammation, although they have no vessels; the cells proliferate and multiply in their capsules; their intercellular substance is modified and absorbed, and only at this stage do vessels appear in this transformed tissue.

It is none the less true, however, that inflammatory processes are infinitely more rapid and more evident in tissues rich in vessels, and formed of cells which resemble embryonic tissues. Under these conditions they pass rapidly on to suppuration, and they reach this termination all the more easily as the inflamed tissues are composed of young cells held together by an intercellular substance of less consistence, and traversed by numerous capillaries. It is, therefore, this greater or less abundance of young cells in the several parts making up bone, which explains their more or less active participation in the phenomena of osteitis.

Experimental Study of Inflammatory Processes in Bone.—In order to properly understand the processes of inflammation in bone, it is necessary to have recourse to experimentation upon animals; there is nothing so easy as to develop osteitis in its different degrees, and to reproduce its different forms, by subjecting one or another element of bone to irritation.[1]

Thus it is possible to irritate the periosteum, the medulla of the central canal, or the spaces of the spongy tissue, and processes may be set up which, although differing one from the other, are always related by common characteristics. The following is what happens in the different tissues. If the surface of the bone be irritated by means of a sharp instrument, introduced through the flesh and carried along the diaphysis so as to make multiple punctures, lacerations, and separations of the periosteum, the bone will, at the end of two or three days, be found to be tumefied at the point where the periosteum has been wounded. At first there occurs an effusion of blood, but soon the periosteum is infiltrated, swells, and becomes thickened, and the more as the subject is younger. This thickening is due to proliferation of the cells of the deep layer of the periosteum, to which I have given the name of osteogenic layer because of its share in the normal formation of the bones and in their regeneration. This layer, which is scarcely perceptible in the normal state, becomes more apparent, and is usually seen in the form of a soft, homogeneous stratum, with a tufted appearance, when the periosteum is torn from the bone; sometimes it has the appearance and consistence of cartilage. This thickening of the periosteum by hyperplasia of the osteogenic layer is characteristic of plastic periostitis. Soon new bone-tissue, in quite regular lamellæ, or in nipple-shaped osteophytes, is formed on the surface of the bone, in such a manner as to produce an exostosis in cases in which a small surface has been irritated, or a hyperostosis if the periosteum has been separated from the greater part of the bone.

This newly-formed subperiosteal osseous tissue becomes organized like normal bone-tissue in the growth of the bone; the vessels which leave the deep surface of the periosteum and pass into the superficial layers of the bone, are centres of lamellar formations which thus mark the boundaries of the Haversian canals.

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[1] Traité Expérimentale et Clinique de la Régénération des Os, t. i. chap. v.

While this process is going on under the periosteum and by transformations of the osteogenic layer, modifications occur on the surface of the bone and in the compact layer which it is the more important to describe because they are characteristic of osteitis, properly so called. Regarded macroscopically, the surface of the bone becomes rugous, and the canals of Havers which open upon its surface enlarge, giving this surface a honey-combed appearance which differs completely from the polish which it presents in the normal state. The rugosities of the bone are caused first by absorption of the bone-substance in the region of the canals of Havers, but soon they result from the deposit of new bone-tissue.

The enlargement of the canals of Havers is the result of absorption of the bone-tissue by the medullary cells which normally line these osseous walls, and which under irritation proliferate with great rapidity in young subjects. Independently of this absorption along the canals of Havers, the compact tissue is eroded and irregularly perforated by medullary granulations which have the same origin, and which have a tendency to form lacunæ in every direction (*lacunar erosion*). Absorption of the old bone-tissue by the medullary cells is then the first stage of osteitis, but, as we shall see, this absorption is only temporary, and is soon followed by reconstitution of the bone-tissue. We see already that the most active tissue in the process of osteitis is that made up of cellular elements which are susceptible of rapid vegetation, as they are found in the period of growth on the deep surface of the periosteum and in the canals of Havers. These elements have much analogy with each other; they have the character of embryonal tissue, and are made up either of small cells (*medullary cells*), or of large cells with multiple nuclei (*myéloplaxes* of Robin). They are found alike under the periosteum and in the medulla, which leads Ranvier to say that the osteogenic layer is only a layer of the medulla, connected with the medulla of the central canal by the cells which line the walls of the canals of Havers.

But, in spite of the presence of analogous cells in the marrow and under the periosteum, these tissues must not be considered as identical. The deep layer of the periosteum has osteogenic properties incomparably more marked.

If, instead of the periphery of the bone, its central tissue be irritated—that is to say, the marrow which is contained in the cavity of the diaphysis—the following phenomena are observed: first, the perforation and the crushing of the medulla cause an effusion of blood, which is soon followed by induration of the medullary tissue. If the marrow is already yellow, the fat is absorbed, and the medullary tissue assumes the characteristics of fœtal marrow. The medullary cells secrete only a more resistant intercellular substance, which increases the consistence of the tissue and gives it a sclerosed appearance. At the same time, what we have observed in the periphery of the canals of Havers takes place in the periphery of the medullary canal; there is absorption of the bone-substance and increase of the space occupied by the medulla.

Such are the phenomena which are seen after irritation of the different tissues constituting bone. But these phenomena represent only one phase of osteitis. When the process has once arrived at the point which I have just indicated, it may stop or continue, and in the latter case it may follow different courses. Either the process continues in the same direction, that is to say, in the way of progressive rarefaction of the bone-substance, when we have a *rarefying osteitis*, or, to this rarefaction there soon succeeds progressive reconstruction of the bone-tissue by the ossification of the osteoblasts found in the canals of Havers, and the bone-substance is seen to resume its original compactness and even to reach a state of greater condensation. Then we have a *condensing osteitis*, likewise called *restitutive* or *productive osteitis.*

Under other circumstances the hyperplastic medullary tissue soon produces pus. Leucocytes are formed in greater or less abundance, and accumulate in appreciable masses under the periosteum or in the medullary canal. They are also formed in all the canals of Havers which contain embryonal cells, and the osseous matter, being bathed in pus, cannot continue to live, but becomes more or less rapidly necrosed. As soon as the process takes this direction we have a *suppurative osteitis*, which is acute or chronic, according as it progresses rapidly or runs its course slowly. These forms of osteitis often follow each other, or are found at the same time in the same inflamed bone. We may produce them experimentally, and determine in this way the relations which they bear to each other. By experimenting upon young animals these different processes may be easily studied; they may be seen, according to the mode and degree of irritation, to proceed in regular succession or to follow an irregular course.

By abandoning to itself a mild osteitis, produced with exclusion of septic agents, reconstruction of the bone is often seen to follow rarefaction, after which everything is restored to order, and at the end of a few weeks the irritated bone has so fully resumed its normal characteristics that it is difficult to distinguish it from healthy bone. If the irritation have been often repeated and long continued—if, above all, it have been set up in an adult subject—reconstruction of the bony substance continues a long time, and the productive osteitis is not only reconstructive but also condensing. This is what is seen around old fractures.

Excess of irritation, produced by exaggeration of the traumatism or by the introduction of septic matters, occasions the formation of pus. This suppuration usually brings on necrosis of a greater or less part of the bone. The vessels contained in the canals of Havers, being able to adapt themselves only with difficulty to the changes induced by the inflammation, are obliterated, and the circulation is interrupted, whence results death of the portion of bone which they nourish. But here again we must consider the age of the tissue, and I have shown[1] that in young animals the compact osseous tissue may disappear by medullization in spite of suppuration of the marrow. A traumatism which will inevitably produce necrosis in an adult, will set up only a rarefying osteitis in a child.

The different forms of osteitis which we shall hereafter find associated in the majority of subacute or even chronic cases seen in man, are artificially produced in animals, and vary with the degree and mode of irritation in different parts of the same bone. They may even be found in different parts of the same bone after a single irritation. The degree of irritation diminishing in proportion as we recede from the point to which the irritating agent has been applied, we can appreciate the influence of the degree of irritation on the form of the process.

If a wound is made in a bone, and a foreign body is introduced by this wound and left in the medullary canal or in the spongy tissue of an epiphysis, the following disturbances will be observed: around the foreign body, the formation of pus; at a certain distance, rarefaction of the bone-substance and proliferation of the medullary substance; further off, the formation of new layers of bone under the periosteum, and ossification of the medulla. If the foreign body be then removed, the process will be seen to follow a reverse course, and the normal state to be re-established little by little. The newly-formed layers of bone, sub-periosteal and intra-medullary, the latter especially, are gradually reabsorbed, whilst the granulations of the space which contained the foreign body are organized first into sclerous and then into osseous tissue.

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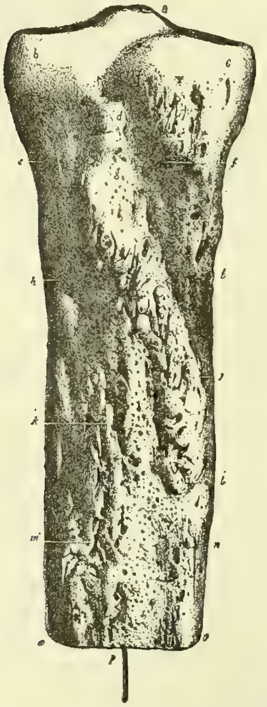
[1] Op. cit.

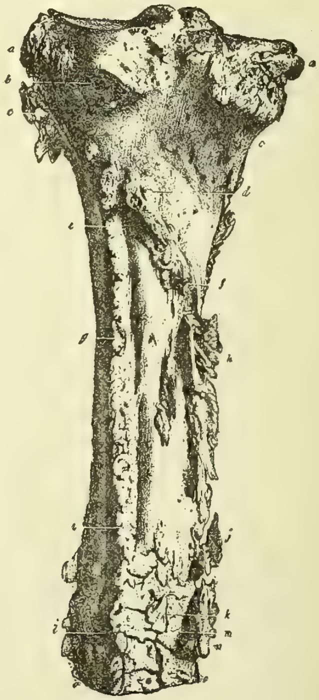
Healthy bone-tissue, artificially or spontaneously inflamed by a traumatic cause, always tends to resume its former character, especially in young subjects. When a bone is subjected to an irritation extending to its different tissues, periosteum and medulla, or limited to one of these, it is found at the end of two or three months that everything has been restored to order, and it is hard to recognize the traces of the inflammation if the bone has enlarged materially in that time. By the time that the process of physiological growth has resumed its course, the bone then formed has been by degrees covered with regularly formed layers from the periosteum, and absorption has taken place in the medullary canal so as to cause the disappearance not only of the intra-medullary ossifications due to artificial inflammation, but also of the deep layers of the old diaphysis. In this incessant work of deposit under the periosteum and of absorption in the central canal, which characterizes the normal increase of the bone, all the osseous tissue existing at the time of the experiment disappears, and is rapidly replaced by entirely new bone.

Fig. 1427.



Rarefying osteitis. (After Gerdy.)

Fig. 1428.



Condensing osteitis. (After Gerdy.)

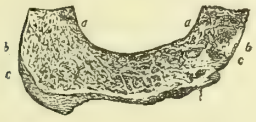
But this disappearance of the traces of traumatic osteitis, a demonstration of which is seen every day in fractures in children, does not occur in the same way in adults. The new formations due to irritation of the subperiosteal tissue, or of the medullary tissue, are much more stable, and sometimes persist indefinitely, as is observed in the callus of adults or old people.

In spontaneous osteitis, or in artificial osteitis in which an attempt has been made to realize, by repeated and varying irritations, the multiplicity of forms which I have already mentioned, the return to the normal state takes place but slowly, and is not possible if sequestra are incarcerated in the medullary cavity, or if their expulsion has been followed by great loss of substance.

If experiments upon animals furnish an explanation of the process of osteitis, they cannot give us results like those which we see in the old osteitis of men, whether spontaneous or traumatic. It is when the process lasts several years that we see those forms which have served as types for those who have described them; those hypertrophied bones made up of rarefied bone-substance without a distinct medullary cavity, or those bones strewn with projecting osteophytes and made up of a white compact substance having the appearance and consistence of ivory.

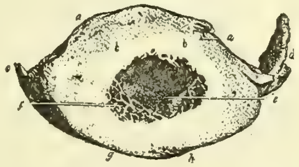
The accompanying figures, taken from Gerdy,[1] represent these two forms of osteitis. Fig. 1427 represents an hypertrophied tibia, the surface of which is rough and uneven, and its osseous substance composed of rarefied tissue, with a very thin compact layer at the periphery. This layer, notwithstanding the osteophytic verrucosities which cover it, is reduced to a slight thickness, and has not a composition comparable to that of normal bone. This is shown in Fig. 1429.

Fig. 1429.



Transverse section of bone affected with rarefying osteitis. (After Gerdy.)

Fig. 1430.



Transverse section of bone affected with condensing osteitis. (After Gerdy.)

In contrast to this rarefying osteitis, Fig. 1428 represents another tibia, the surface of which is covered with elevated osteophytes, especially along the edges of the bone. Under this osteophytic layer the original bone-tissue has undergone the process of condensing osteitis. In section (Fig. 1430) it is seen to be formed of a white compact layer of dense texture, without visible bloodvessels.

The productive osteitis which gives rise to this condensation of the osseous tissue, is sometimes carried to such a point that the bone acquires an extreme hardness. The production of bone may extend into the medullary canal, which becomes more and more narrow, and is finally obliterated. Then the bone becomes very dense, and exactly resembles ivory.

Direct and Indirect Irritation of the Various Elements of Bone.—We have as yet examined only the direct effects of irritation upon one of the elements of bone, that is to say, the effects produced upon the tissue which has been directly and immediately subjected to contact with the irritating agent. But this irritation is not limited to the point touched, it extends more or less rapidly, and with more or less intensity, to other parts, and may react upon the whole organ. In this extension the irritation is weakened, and produces varying effects. Intense and destructive at the point touched, a little further off it leads to absorption of the calcareous matter, and at a distance still further removed from its point of departure causes immediate plastic processes.

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[1] Gerdy, Maladies des Organes des Movements. (Plates III. and IV., reduced.)

Let us take an example: if a foreign body is introduced into the medullary canal of the diaphysis of a long bone of a young animal, a focus of suppuration is formed at its site; the medullary substance in contact with it is destroyed or transformed into purulent granulations, and the bony laminæ in contact with it become more or less necrosed. But at about a centimetre beyond the point of suppuration, the medulla is harder and begins to ossify; in the bone, beyond the necrosed lamina, there is rarefaction, the canals of Havers being enlarged; under the periosteum, the irritation being still more feeble provokes secondarily a hyperplastic process, which continues and soon manifests itself by a considerable increase in the thickness of the bone. The new subperiosteal mass sometimes attains a thickness of from seven to eight centimetres, and ensheathes the whole of the old diaphysis. This indirect irritation of the periosteum is more fruitful of ossification than direct irritation, which is apt frequently to pass its limits and induce suppuration. This is a fact which it is important not to forget in interpreting the phenomena which accompany regeneration of bone, and which we shall return to hereafter in connection with necrosis.

The same physiological fact is observed in the treatment of pseudarthroses by the seton. When a false joint is traversed, that is to say, the seat of an ununited fracture, suppuration is provoked along the course of the seton, and even the osteoid products already formed may disappear in its neighborhood; but at a little distance, and all around, in all the ossifiable tissues, there occurs a hyperplasia which results in the formation of osseous tissue, and in this way consolidation of the fracture is secured. Victorin Ollier[1] has well demonstrated the influence of different degrees of irritation upon the course of the process of ossification, and has shown experimentally that this process may be hastened or made to retrograde according to the intensity and permanence of the irritation.

I shall mention hereafter, in speaking of the influence of osteitis upon the growth of bones, the varied effects of irritation of the epiphyseal cartilage, according as it is direct or indirect. Let me only mention here that persistent and moderate irritation of one of the elements of bone manifests itself in a more abundant proliferation of the organs of growth, and finally by hypertrophy of the bone in length or in thickness, provided that it does not act directly upon the epiphyseal cartilage. Lacerations of the periosteum, bruises of the medulla, the various wounds of bone in the middle of the diaphysis in young subjects, provoke indirectly irritation of the physiological zone of proliferation, which is soon manifested by an increased length of the part.

The processes of experimental osteitis, and those of traumatic osteitis in man, are considerably influenced by septic agents and the general state of health of the subject. A traumatism which will provoke only hyperplastic processes and increase of medullary ossification in a healthy individual, will produce a suppurative inflammation of the medulla, and processes which are fruitless so far as ossification is concerned, in one who is ill or whose nutrition is impaired. It is necessary then to consider, in determining the causes which vary the course of osteitis, not only the degree and the mode of irritation, but also the physiological and pathological nature of the soil; that is to say, the state of the patient's constitution and general health.

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[1] Vict. Ollier, Du cal et de ses modifications sous l'influence de l'irritation. Thèse de Montpellier, 1864.

MINUTE PHENOMENA OF OSSEOUS INFLAMMATION; ABSORPTION OF BONE-SUBSTANCE BY MEDULLARY CELLS; ACTION OF OSTEOPLASTS.—We have seen that enlargement of the canals of Havers and absorption of the bone-substance constitute the first macroscopically appreciable phenomenon, and therefore form the first stage of osteitis. But how does this absorption take place? By what mechanism is it accomplished? What is its essential organ?

In this process it is the most recent bony lamellæ, the most newly-formed layers of osteoplasts, which are first absorbed. In the lamellar system of the Haversian canals, the most central are the most recent, and those which of necessity disappear first. Under the periosteum, the fundamental lamellæ are absorbed in like manner, the most recent first. It was believed for a long time, following Virchow, that the cells of the osteoplasts contained in these lamellæ took an active part in this absorption, and were the point of departure of a new proliferation. But the most recent researches do not favor this hypothesis. It has not been possible to detect these transformations of the osteoplasts, which had been acknowledged more from analogy perhaps than from direct observation; and Ranvier, who some years ago had adopted the first theory, now acknowledges that it is very difficult to recognize this process, that is to say, the return to vegetative life of the cells contained in the bone-corpuscles. "It is very difficult," say Cornil and Ranvier,[1] "to comprehend the exact cause of the absorption of bone in osteitis. If, in intense osteitis, there are sometimes bone cavities which contain a large cell or several cells, resulting from multiplication of the primitive cell, in such a manner that the enlarged cavity may open into a medullary space, nevertheless this is not the habitual method of absorption of the bony trabeculæ." Kölliker, Wagner, Busch, and others, in Germany, and Lovén, in Sweden, have combated the theory of Virchow, and have arrived at the conclusion that the bone-corpuscles disappear without leaving any trace, and especially without returning to the state of young cells fitted for proliferation. It was then asked, what was the agent of this absorption, and Kölliker suggested that the large cells of the medulla, the cells with multiple nuclei or *myéloplaxes* of Robin, were its essential agents. These cells, which are endowed with special chemical properties, have for their function to dissolve the contiguous bone-substance, whence the name *osteoclast* or *osteophage* which he has given to them. The special action of these cells does not appear to me to have been demonstrated: the rapidity of the absorption of bone is not in proportion to their number or their dimensions, and they are not always found at the periphery of the medullary granulations which penetrate into the lacunæ of Howship. According to Ranvier, these cells, the so-called osteoclasts, are found in the course of osseous trabeculæ in the process of growth, as well as in the course of those which are being absorbed in inflamed bone. I do not, therefore, attribute the property of absorption of bone-tissue to any particular cell of the medulla, but to all the young cells which constitute medullary granulations, and especially to the vascular element of these granulations.

In regard to the changes which take place in the soft parts of the bone (periosteum, medulla), they are analogous to those which are seen in all inflamed tissues, while having certain peculiarities dependent upon their structure. The external layer of the periosteum is infiltrated and thickened, but it is in the osteogenic layer that the most important phenomena take place, which determine the form of the osteitis. These elements return to the embryonic state, and, according to the direction which the process takes, give rise to the formation of pus, or to a new bone-formation, which is only an exaggeration of the phases of normal ossification. In the medullary tissue analogous processes occur: the small cells multiply, and the large cells become more apparent and at the same time more numerous. The inter-cellular substance assumes at a certain period a fibrous appearance, becomes sclerosed, and afterward produces trabecular bone-formations, which persist or are absorbed according to the course of the inflammation.

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[1] Cornil et Ranvier, Manuel d'Histologie Pathologique, 2e édit., p. 391.

INFLAMMATION OF BONE IN RELATION TO ITS CONSTITUENT TISSUES; PERIOSTITIS; OSTEOMYELITIS, ETC.

The multiplied vascular relations which exist between the different tissues constituting bone, and the continuity of the subperiosteal osteogenic layer with the central medullary tissue by means of the cellular elements contained in the canals of Havers, establish a physiological solidarity between these different elements, and explain the closeness of their pathological relations. Inflammation is communicated from one to the other by reason of the similarity of their anatomical elements, and of the abundance of bloodvessels which traverse them. Yet for a long time inflammations of the periosteum and of the medulla were described separately, and before Crampton had created the word *periostitis*, descriptions had been given of inflammation both of the external membrane of the bones (Boerhaave, Van Swieten), and of the medullary membrane. Superficial inflammations were attributed to the periosteum, deep ones to the medulla. In our day, these distinctions have been made more precise, and the majority of authors have described periostitis and osteomyelitis separately. The name *medullitis* has also been given to inflammation of the medulla of the central canal. Inflammation starts, in fact, in either one or other of the tissues constituting bone, and may remain limited to it for a certain period. At other times it attacks almost simultaneously all the tissues of the bone, or may pass from one to the other with great rapidity, when it is difficult to classify the case either among inflammations of the periosteum or among those of the medulla. It is now no longer a periostitis or an endosteitis; it is an inflammation of the bone, or, in other words, an *osteitis.*

The term osteitis is not applicable solely to inflammation of the substance of bone. As has been said above, bone-substance inflames only by means of the soft and vascular elements which it contains; whence, though it is the characteristic substance of bone, it constitutes the least important element in its pathological processes. On this account it has sometimes been said that in inflammation of bone there is only periostitis or medullitis.

We should in regard to osteitis refrain from disputing about words, and should not press too far the spirit of systematic classification. Therefore, while admitting isolated inflammation of the periosteum, and of the central medulla, I shall occupy myself especially with inflammation of bone. I shall describe it under the name *osteitis*, this word signifying not inflammation of bone-substance, but inflammation of the osseous tissue, consisting at once of periosteum, of medullary tissue, and of bone-substance, properly so called.

Having made these reservations in regard to the inter-connection of inflammations of the various elements of bone, I shall give a special description of periostitis and of osteomyelitis. The opinions of surgeons have often differed in regard to the share of these separate inflammations in the pathology of the osseous system; sometimes they have exaggerated the importance of periostitis; sometimes they have been able to see only osteomyelitis. We shall see that it is always useful to take both of them into account, not only as a matter of theoretical interest, but also from the stand-point of therapeusis. Independently of the differences in inflammations of bones according to the anatomical element involved, distinctions must be established according to the region of the bone which is implicated. These distinctions are, from a practical stand-point, even more important than the former.

A long bone (let us take the femur for example) is made up during the period of growth, that is to say, during the period of life when the exposure to affections of the bones is greatest, of three distinct pieces; the diaphysis and the epiphyses. These pieces are separated by the epiphyseal or connecting cartilages, which, isolating them anatomically, form a more or less resistant barrier to the propagation of their respective inflammations.

It is important to distinguish these several inflammations. That of the diaphysis bears the name of *diaphysitis*, that of the epiphyses will be called *epiphysitis.* The different relations of these two portions of the bone, and the connection of the epiphyses with the terminal articulations, impress upon these affections a different course, explicable by their anatomical connections.

When the whole of a bone is inflamed, when the diaphysis and its terminal epiphyses are invaded, the disorder bears the name of *panosteitis*, that is to say, inflammation of the whole bone. This total inflammation is more rare than one would at first believe. The large bones of the extremities are rarely involved from one articulation to the other. It is seen rather in the small bones, and in the short bones which have only a single centre of ossification and no intermediate cartilage between their different prominences.

Spontaneous inflammations of the bones occupy seats of election, corresponding, as I have already said, to the points of greatest activity of physiological development. The morbid predisposition is, all other things being equal, in direct ratio to the activity of proliferation of the anatomical elements. The regions of the bone at which growth is chiefly taking place *at any given* period, are by that fact peculiarly predisposed to become the seats of pathological new formations, and especially of acute or chronic inflammations.

Spontaneous inflammations of the bones are peculiarly diseases of childhood and adolescence, that is to say, the period during which the bone grows. It is at this age that the action of cold, forced exercise, fatigue of the skeleton, or juxta-epiphyseal strain, gives rise, under the influence of a scrofulous or rheumatic predisposition, or of a general, systemic poisoning, to those acute or subacute lesions which are chiefly characterized by being produced where the formative activity is most developed—in the neighborhood of the juxta-epiphyseal portions of the diaphysis, where increase in length takes place, and under the periosteum, where increase in thickness occurs. Hence the frequency of those forms of osteitis, osteo-periostitis, and osteomyelitis, which I have called juxta-epiphyseal, and which are seen not only at the extremities of the diaphyses of long bones, but also upon the borders or surfaces of flat and short bones which are connected with a cartilage of development (spinal border of the scapula, crest of the ilium, posterior third of the calcaneum, anterior extremities of the ribs). The crest of the ilium and the spinal border of the scapula, in young subjects, are constituted by an epiphyseal margin which is separated from the diaphysis by a connecting cartilage. Inflammation of the diaphyseal border is the analogue of inflammation of the terminal portions of the long bones; it is also a juxta-epiphyseal osteitis. Marginal osteitis is an inflammation of the epiphysis.

The short bones which have no epiphysis, and the flat bones which have only one centre of ossification, increase by their periphery. Peripheral apposition is the general formula which I have reached in my experiments upon the growth of bone; interstitial growth is absent, or is insignificant.[1]

Marginal osteitis of certain flat bones (angle of the jaw), and sutural osteitis of the cranium and of the bones of the face, are to be classified, during childhood and adolescence, with the osteitis of growth.

Juxta-epiphyseal osteitis is acute or chronic. When acute, it often overleaps the limits of the connecting cartilage which has held it back for a certain length of time; then it is propagated to the epiphysis and attacks the terminal articulation. When chronic, it threatens the articulations less directly, but invades them ultimately, sooner or later according to the relations between the connecting cartilages and synovial membranes.

A mistake has sometimes been made as to the significance of juxta-epiphyseal osteitis. Because the grave and infective form has been most carefully described,[2] it has been supposed that this affection is no other than that which is known under the names of diffuse phlegmonous periostitis, separation of the epiphyses, typhus of the limbs, etc. This is an error which I have always combated; for ever since the beginning of my researches, in 1860, I have seen chronic and benign forms of the disease.

The word juxta-epiphyseal is a qualificative, which indicates the seat and not the nature of the affection. My experimental researches upon the growth of bone, while demonstrating the part of the connecting cartilage in increase of height, have led me to attach the greatest importance to inflammatory lesions situated at the edges of this cartilage, in the spongy tissue of the diaphysis. This newly formed spongy tissue, very vascular and united to the cartilage by a spongy layer which is not yet bone, but which no longer has the cartilaginous structure, is the portion of the bone in which the most active transformations take place during the period of growth. Upon the edges of the cartilage, the phenomena of cellular proliferation are accomplished with the greatest rapidity; transformation of cartilage-cells into marrow cells and into osteoblasts; transformation of these osteoblasts into bone-corpuscles; constitution of the web of the bone and formation of spaces filled with marrow; in fine, incessant increase in the height of the bony column. The marrow contained in the spongy tissue is very vascular; it is of a rose-color, and not charged with fat; it communicates with the marrow of the central canal, and, on the other hand, is connected with the periosteum by numerous vascular canals.

This spongy tissue makes up the expanded portions of the diaphysis, and is often the seat of acute or chronic inflammations, to which, under the influence of the physiological perturbations or the traumatic causes which we shall hereafter examine, the incessant transformations to which it is subject expose it. Inflammation may be developed in these various layers, at a greater or less distance from the connecting cartilage. If it attacks the cartilage, it alters its tissue, disturbs its nutrition, disintegrates it, and puts a more or less complete stop to the growth of the bone. If it does not attack the cartilage directly, its evolution will not be disturbed, but the inflammation may travel in a different direction, towards the central canal of the bone, or may advance towards the superficies and then invade the sub-periosteal layers.

I have given the name juxta-epiphyseal to that expanded part of the diaphysis which is included between the central canal and the connecting cartilage, and it will suffice to bear in mind its structure and its relations in order to comprehend its importance in relation to osseous pathology.

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[1] Recherches expérimentales sur le mode d'accroissement des os. (Archives de Physiologie, 1872.)

[2] Gamet, De l'ostéo-périostite juxta-épiphysaire. Thèse de Paris, 1862; Sezary, De l'ostéite aiguë chez les enfants et les adolescents. Thèse de Paris, 1870.

The connecting cartilage is intimately adherent to the periosteum, with which it is continuous and blended at its circumference. The older writers even considered it as a dependency of the periosteum. This continuity is well seen in separations of the epiphyses, when the extremity of a diaphysis separated from its cartilage breaks through the ensheathing periosteum, and protrudes through the tear in the midst of the muscles. In this sudden separation there remains on the side of the cartilage the spongy layer, and under the periosteum the osteogenic layer, which is very easily seen in young children, and the deep parts of which have already undergone the first stage of ossification. There is also under the periosteum a spongy layer which is continuous with the same layer at the level of the cartilage.

At the terminal portions of the diaphysis there is also found the principal zone of growth in the bone: near the cartilage, the elements of growth in length; under the periosteum, the elements of growth in thickness. This zone of physiological proliferation is also the zone of election of pathological processes. And we must not only consider these processes at the periphery of the bone; corresponding incessant transformations take place in the cavities of the spongy tissue during the whole period of growth.

As the seat of the most active growth of the bones, the juxta-epiphyseal expansion is, by this very fact, the region most predisposed to a variety of inflammations. Related on the one hand to the connecting cartilage, on the other to the central canal of the medulla, and communicating readily with the periosteum by numerous vascular openings, it constitutes a central focus whence inflammation may readily radiate in all directions, except in that of the epiphysis, where the cartilage arrests it for a certain length of time. The inflammations which are produced in the spongy tissue, on the border of the connecting cartilage, take the form of osteo-myelitis, and differ from medullitis or osteo-myelitis of the central canal inasmuch as they cannot progress as rapidly, stopped as they are by the walls of the vacuoles of the spongy tissue. They differ from them above all in that they may easily show themselves under the periosteum, from which they are separated, at the edge of the cartilage, by only a thin layer of compact tissue, which is easily medullized. This explains the frequent spontaneous issue of pus under the periosteum, coming from the cavities of the spongy tissue, and enables us to understand at the same time the error which may be made as to its true origin.

It is in this region, under the periosteum or in the spongy tissue, that the majority of inflammations of the diaphysis begin during the period of growth, spreading through the medulla and the periosteum to the whole of this portion of the bone, and giving rise to the various lesions which we are about to study.

The idea of juxta-epiphyseal osteitis then appears to me one of the fundamental points of the pathology of bones; wherefore I shall not cease to call attention to its nosological significance and to its therapeutic consequences. The juxta-epiphyseal portion is much more frequently than the adjacent epiphyseal tissue the point of departure for the acute osteitis of childhood and adolescence. The proliferation of ossifiable elements, and the growth of the bone which is its consequence, are not equal on the two faces of the connecting cartilage. They are much more marked on the diaphyseal face, whence arises a permanent physiological congestion which prepares the ground for pathological attacks. The length of the bone derived from the epiphyseal faces of its two connecting cartilages represents, on an average, hardly the fifteenth of the length gained from the two diaphyseal faces of the same cartilages.

But the bone grows not only in length, it grows also in thickness by the successive ossification of the osteoblasts furnished by the osteogenic layer of the periosteum. Although less obvious than the increase in length, this increase in thickness goes on constantly until the consolidation of the epiphyses with the shaft, and continues insensibly for a long time afterwards.

This activity of the subperiosteal elements explains how the internal surface of the periosteum is also frequently the point of departure for osseous inflammations, which may be limited, or may extend. In the latter case, they spread all round the bone, and may reach the medulla through the juxta-epiphyseal regions, bringing about those isolations of the diaphysis, or those more or less extensive necroses, which so often necessitate our interference.

The central medulla may also be the point of departure for acute inflammations, which immediately become grave because of the facility of their propagation to the whole of the bone, and of the favorable conditions which they present for pyæmic or septic poisoning. A continual work of absorption and deposition of bone-substance takes place on the internal face of the medullary canal; whence the disposition of this region to be also a point of departure for inflammations of bone during the period of growth.

Independent of the physiological causes which explain the origin and the places of election of inflammations of the bones, we must concede a considerable part to traumatisms, and not only to violent traumatisms, which are relatively rare, but also to those slight and transiently painful traumatisms which, in spite of their frequency, very constantly pass unperceived in young children.

The causes which set up, in delicate and scrofulous children, juxta-epiphyseal osteitis, have not been adequately appreciated, and, without seeking to explain its mechanism, it has been deemed sufficient to say that it is the result of the scrofulous diathesis or of a tuberculous affection. What explains to my mind this localization in a multitude of cases, is the juxta-epiphyseal strain produced by violent movements of the articulations, and by the falls which are so frequent in early age. Violent movements of the joints in young children do not generally produce appreciable articular lesions, but they react upon the bone above the connecting cartilage, that is to say, upon the spongy tissue of the juxta-epiphyseal region, which is the weakest part of the bone, and the least capable of resisting twists, exaggerated compression, or forced movements. Under the influence of these different traumatisms, there take place in the juxta-epiphyseal bone-tissue, crushings, trabecular fractures, separations of the periosteum and of the diaphyseal cartilage, which may be the starting-point of any of the forms of osteomyelitis.[1]

The bone-cells of the epiphyses themselves likewise feel the effects of these shocks and violent movements, but here their effects are less apparent in experiments on the cadaver. However, they explain the development of epiphyseal osteitis, which is so often the origin of acute or fungous arthritis in young subjects.

Juxta-epiphyseal osteitis, developed in the long bones of the limbs, is usually single, but is sometimes double in the same bone. It passes from one end of the diaphysis to the other, either along the periosteum or along the medullary canal. Usually the inflammation leaves traces of its passage along the whole of the diaphysis, by giving rise to more or less appreciable suppurations of the periosteum or medulla; but at other times it traverses the diaphyseal tube without stopping there, giving rise perhaps to a few osteophytes under the periosteum, or to a few medullary ossifications, and going on to suppuration only in the two ends of the diaphysis, in the juxta-epiphyseal spongy tissue. There are then two distinct centres of suppuration, one at each end of the bone. This is the variety of osteitis which I designate under the name of bipolar. This invasion of the two juxta-epiphyseal regions of the same bone is frequent in the tibia.

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[1] De l'entorse juxta-epiphysaire (Revue Mensuelle de Médecine et de Chirurgie, 1881).

GENERAL SYMPTOMATOLOGY OF ACUTE INFLAMMATIONS OF BONE.

Inflammations of bone are sometimes very difficult to diagnosticate, because the organs attacked lie so deep. In some cases chronic inflammations follow so slow a course, and give rise to so little pain, that they are not diagnosticated until the cold abscesses which they cause appear in sight. As to acute inflammations, they may be confounded with phlegmons of different origin.

We shall here study especially acute and subacute inflammations ; chronic inflammations are associated with scrofulous and tuberculous lesions, or with syphilis, and are described in other articles.

The name periostitis is applicable to an inflammation of the totality of the periosteum; but, as I have already said, it is on the deep face of the periosteum, in the osteogenic layer in young subjects, and in the deep lamellar layer in old subjects, that the phenomena of inflammation oftenest occur. The fibrous external layer is only exceptionally the primary seat of inflammation, and still more exceptionally its exclusive seat. Inflammation may nevertheless develop on its external surface, and outside of it, in the parosteal layers.

Especially after traumatisms may there be observed over superficial bones, such as the tibia, the ribs, the cranium, etc., external inflammations which may simulate true osteitis. An abscess forms, it is opened, and the bone is not found denuded, but only the periosteum thickened at this point. These are the inflammations which have been called external periostitis by Gaujot and Duplay, and which I long ago described under the names of *inflammation of the parosteal layers*, and of *parostitis.* This variety of inflammation undoubtedly exists, but one must not be in too great haste to admit its presence when there are at the same time signs of periostitis or of osteitis. One often believes at first that the bone is intact; but on searching carefully, a little denuded point is found which has been the origin of the abscess that was found spread in front of the periosteum. In consequence of a contusion, the periosteum may have been bruised over a considerable extent, and torn in a single point alone, where the force has been more directly applied. From this point the inflammation starts, and this osteitis, notwithstanding its slight extent, will keep up suppuration in the future. Therefore it is not well, in these parosteal inflammations, to be too quick to deny the participation of the bone. Whenever suppuration, developed on the surface of a bone, continues for a long time, it is advisable to search carefully for its starting-point, and to suspect that it is in the bone itself. Search conducted with this in view will usually be crowned with success.

In case a contusion of the periosteum, or spontaneous inflammation of its external layer, should give rise to a persistent swelling around a bone, the subjacent osseous layers, those which are immediately under the periosteum, feel more or less the effect of the propagation of the inflammation. There may be produced here secondarily a subperiosteal abscess ; or, if the inflammation do not go so far as suppuration, layers of osteophytes are formed under the periosteum. Chronic inflammations developed around a bone produce this latter result; old ulcers of the leg give rise ultimately to hypertrophy of the bone, or at least to signs of plastic periostitis.

There may then be described two varieties of periostitis, external periostitis and internal periostitis, or endo-periostitis. The latter is the more common and the more important, because of the anatomical relations of the deep layer of the periosteum with the other constituent tissues of the bone. Besides, this layer is never inflamed without more or less participation of the fibrous layer in the inflammation; so that it is not worth while to try to separate that which is always more or less united. It is best simply to distinguish from periostitis proper, inflammation of the parosteal layers, which in certain cases is found to have peculiar characteristics, remaining independent of the bone and without appreciable influence upon it, unlike true inflammation of the periosteum, which is always propagated more or less to the other elements of the bone.

In bones which are superficial and easily accessible, osteitis manifests itself by an increase in size, and by pains which in certain bones are characteristic. The bone swells, but this increase in volume is not due to the bone-substance itself; it is the result either of thickening of the periosteum or of infiltration of the parosteal layers, that is to say, of the cellular tissue which surrounds it. Under the influence of this double cause a diaphysis may attain an enormous size; if the irritative process be long continued in a tibia or femur, the diameter of the bone may, after a certain time, appear at the central part double or even treble its normal size. This thickening is only apparent; it is made up in its deepest part by the osseous layers under the periosteum, which themselves are covered by the thickened fibrous layer of the periosteum, and more externally by the thickening and infiltration of the parosteal layers (muscle and connective tissue). This last constituent of the swelling of the bone is very variable, and tends moreover to disappear gradually as the inflammation subsides. When the bone is subcutaneous, this thickening of the periosteum, diffuse or limited, is accompanied by heat appreciable to the hand. It is more or less painful, according to the course of the inflammation. Painless, or nearly so, in the slow and chronic forms, the periosteal swelling is accompanied by acute pain, with nocturnal exacerbations, when the course of the affection is acute or subacute. These pains are increased by pressure, and may become very severe in certain region. They increase in intensity when pus is formed under the periosteum. They are of a nocturnal type, but in certain regions they are almost continuous, and are accompanied by high fever and all the signs of deep inflammations. The periosteum, which forms a continuous membrane around the bone, constitutes a barrier which is long impassable to the products of inflammation. There is, therefore, strangulation of the inflammatory tissues; and, although the resistance of the periosteum is infinitely less than that of the bony case of the diaphysis, it is easy to understand the acuteness of the pains and their persistence, as long as the periosteum is not naturally perforated or artificially incised.

There is nothing so variable as the general symptoms and reaction in inflammations of the periosteum; wanting, or almost wanting, in syphilitic periostitis and in some cases of periostitis of traumatic origin, these symptoms develop with rapidity, and assume a very grave appearance, in the acute periostitis of childhood and adolescence. Sometimes, indeed, the general phenomena precede the local symptoms, as we shall see in connection with infectious periostitis. What characterizes in a general way inflammation of the periosteum, is the tumefaction of the bone, which appears as the initial phenomenon, or at least at the very beginning of the local manifestations, and, further, the superficial seat of the pain. As to its intensity, it is relatively less than in the more deeply seated osseous inflammations.

These two characteristics are manifested often enough at the outset of the inflammation to justify the statement that the part affected is the periosteum.

But in a considerable number of cases it is not possible to pronounce with certainty upon this point, and one should even speak with reserve, on account of the anatomical and physiological relations of the different tissues of the bone.

Inflammation of the central medulla or of the spongy tissue of the bone (*endosteitis*) is manifested from the beginning by dull and deep-seated pains. These soon assume a more or less acute character, and are cutting or gnawing; but what distinguishes them for a long time, when the patient is able to give a good account of his sensations, is their deep character, their intra-osseous situation.

When they declare themselves without anything being apparent to sight or to touch on the surface of the bone; when neither periosteal nor parosteal swelling can be distinguished, nor excessive tenderness on pressure, a diagnosis of osteo-myelitis or of osteitis beginning in the central part of the bone, should be made. If it be limited to the expanded portion of the bone, there is an osteo-myelitis of the spongy tissue, a juxta-epiphyseal osteitis; if it extend along the bone, if it correspond to the region occupied by the central marrow, the diagnosis of medullitis should be made. Often it will be found more or less in the two extremities of the diaphysis, the central portion being painless or having very little pain. This localization of pain in the two extremities of the diaphysis calls for a diagnosis of bi-polar osteo-myelitis.

In some cases, before the appearance of the external, that is to say periosteal, swelling, these deep bone-pains are accompanied by a slight hydrarthrosis in the adjoining articulation or articulations. This is a valuable sign for the recognition of osteo-myelitis at its outset.

But these deep pains, coinciding with an absence of periosteal swelling and of superficial pain, mark often only a very transient stage of the disease. Soon the periosteum swells and becomes sensitive, the parosteal layers are infiltrated, and the characteristics are observed which I have assigned to periostitis. But, if one has not witnessed the onset of the attack, and followed the development of the local manifestations, it is not possible to diagnosticate the initial lesion, and thus to say whether there has been originally a periostitis or an osteo-myelitis. Then the diagnosis of osteitis is the only one acceptable from both a theoretical and a practical point of view.

It will not do, then, to rely upon the exaggerated swelling of the periosteum and upon the apparent increase in size of the bone, which is often considerable, and to say that the case is one of periostitis. To do so would be to commit a grave error.

I have referred, in connection with osteitis experimentally produced, to the effect of indirect irritation of the periosteum; and I have mentioned the enormous sub-periosteal ossifications which I had observed in my experiments[1] after irritation of the marrow. Clinical experience furnishes analogous examples every day.

As a result of osteo-myelitis terminating in suppuration and the formation of deep sequestra which remain incarcerated, the tibia or femur may be seen to increase progressively in size and to attain an enormous thickness. There is no more pain, but the source of irritation persists and the plastic periostitis continues. It may in the space of three months, as I have recently seen in the ulna of a patient twelve years old, provoke a sub-periosteal ossification which is double, or more than double, the real diameter of the bone. To penetrate to the medullary canal, I had first to go through a layer of new bone eight millimetres thick, and then through the old diaphysis which retained its vitality through the greater part of its thickness, and which was distinguished from the new bone by its whiteness and its compactness.

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[1] Traité de la Régénération des Os, t. i. chap. v.

The peripheral swelling of the bone, that is to say, the sub-periosteal or parosteal infiltration, terminates in various ways; either it undergoes gradual resolution, or it terminates in the production of osteophytes, or it even originates an abscess.

Sub-periosteal abscess, the course of which is very variable and which may occur in the form of either a cold or a phlegmonous abscess, indicates that the inflammation is situated under the periosteum, but it does not indicate that the inflammation has started under this membrane. It may be consecutive to an inflammation of the medulla, as I have already pointed out above, and may be only the last step of a process which has begun in the medulla either of the central canal or of the spongy tissue. If a subperiosteal abscess be limited, if it occupy only a small part of the surface or of one of the faces of the bone, if it be not accompanied by deep, gnawing pain, it may be attributed to a primary periostitis. But if fluctuation appear only at a late period, if it show itself first in the juxta-epiphyseal regions, where communication between the periosteum and the medulla takes place most readily on account of the abundance of vascular openings and the thinness of the compact layer, we should recognize a consecutive periostitis, and should expect to find, not only pus under the periosteum, but also oil-globules, due to transudation of the medullary oil through the canals of Havers.

Suppuration of the bones is seen under various aspects, according to the course and intensity of the inflammation and according to the tissue first affected; it presents also differences fully as important, according to the nature of the affection.

As we are not occupied in this article with either tuberculous or syphilitic lesions of the bones, we may at once eliminate gummata and tuberculous abscesses, which belong to the chronic forms of osteitis, and which have peculiar characteristics: ill-formed pus, grumous, sometimes pitchy, ropy, with or without osseous particles.

In acute or subacute osteitis, the liquid which has been effused under the periosteum, in the periosteal sheath, or even outside of it in the parosteal layers, appears, after rupture of this sheath, sometimes in the form of a clear liquid, only slightly turbid from the presence of white or red corpuscles, sometimes in the form of pus like the laudable pus of a subcutaneous abscess. In either case it may be accompanied by a greater or less quantity of oil-globules. When these oil-globules run together in a serous and almost transparent liquid, they give this liquid the appearance of greasy broth. I long ago explained these varieties in the appearance of the liquids accumulated under the periosteum or in the parosteal layers, and I described in 1872[1] these collections of ropy liquid, transparent as synovial fluid, which are sometimes met with in the inflammations of bone to which I have given the name of albuminous periostitis. I observed this affection for the first time in 1868, in a young patient fifteen years old, affected with osteo-periostitis of the lower extremity of the diaphysis of the femur. A collection had formed above and to the inner side of the knee-joint. It formed a tumor oblong in the direction of the axis of the femur, lifted up the muscular mass, and was the seat of evident fluctuation. The general symptoms which had been troublesome for some days (continuous fever and intense pain) had abated, and even the local heat had almost disappeared. I diagnosticated a subperiosteal abscess, and made an incision into the tumor with a bistoury. There escaped a gush of clear, ropy liquid like synovia. Those who were present believed that I had opened the joint, but I had done nothing of the kind: the liquid was of bony origin. When I emptied the upper part of the tumor, some oil-globules were seen mingled with the ropy fluid. A stylet introduced into the sac revealed a small extent of denuded bone, a centimetre square at most. After having emptied the sac I closed the little wound by bringing its edges together, and it united. The joint remained untouched, and there was no threat of articular suppuration. The ropy liquid formed again in its periosteal sac, which opened spontaneously some months afterwards. There resulted a small fistulous track which conducted the stylet down to a small denuded portion of the juxta-epiphyseal region of the diaphysis. This portion was cast off afterwards in the shape of a small fragmentary sequestrum, and the suppuration never invaded the synovial membrane, although the nearness of the osteitis had led to a slight propagation of the inflammation to the fibrous tissues of the joint. Flexion of the knee was not complete.

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[1] Poncet, De la périostite albuminense (Gazette Hebdomadaire de Médecine et Chirurgie).

Between the transparent liquid with an albuminous appearance, and opaque creamy pus, all the intermediate forms may be met with; the albuminous liquid is often only the first degree of an inflammation which is going to end in suppuration; but not every sub-periosteal suppuration begins by the accumulation of an albuminous liquid in appreciable quantity. There is often found from the beginning, under the periosteum, pus looking like that which is found in other tissues. It is in liquids rapidly formed under the periosteum, or outside of it, that this serous or albuminous appearance is found. Several times, on opening collections of fluid over bone affected with acute inflammation, with severe febrile phenomena, I have seen, instead of true pus, a sero-sanguinolent fluid, barely rendered turbid by a few leucocytes; and patients themselves sometimes mention, in their recital of their ills, the issue of a watery or slightly sanguinolent fluid.

The presence of oil-globules may be noticed in these different liquids, whatever may be their consistence; but in greater abundance in serous, than in thick and viscous liquids. These oil-globules are due to the transudation of the medullary fat in consequence of increase of intra-osseous pressure and rupture of the fat-vesicles. This transudation is produced experimentally when a stick is driven into the medullary canal of a long bone (Hartmann) immersed in a liquid at the temperature of the body. As the presence of oil-globules is far from constant in osteo-myelitis, the fat being speedily transformed in the inflamed tissues, it must be acknowledged that special physical conditions are necessary, the chief of which seem to be interference with the venous circulation and greater or less friability of the walls of the fat-cells. The conditions differ according as the inflammation comes on suddenly, with all its intensity, in a previously healthy medullary tissue, or as it declares itself in a medulla already influenced by a slight degree of irritation. In the latter case the fat has already gradually disappeared, and the medullary cells are united by an intercellular substance more resistant and less suited to permit the passage of oil-globules through them.

The medullary tissue, contained in an inextensible envelope, whether it be the medulla of the central canal or of the areolæ of the spongy tissue, is especially disposed to strangulation as soon as it is inflamed. It cannot undergo the increase in size which is caused by hyperæmia and inflammatory proliferation without being exposed to strangulation and mortification. Hence arise the deep and persistent pains which accompany acute or chronic inflammation of the medulla, and which have always attracted the attention of observers. These pains are of different types; they are called osteocopic pains, and have been particularly described under this name in connection with syphilis; but they are present more or less in all the acute or subacute forms of osteo-myelitis. They are not found in some forms of tuberculous osteitis, and in neoplastic processes whose course is slow, when absorption of the peripheral bony trabeculæ has led to the disappearance of the physical conditions which produce strangulation. I shall return to this subject when speaking of neuralgic osteitis.

Intra-osseous pains often begin with a vague discomfort in the bone, with the sensation of an indefinable *malaise.* The patient complains of weight in the member; he sometimes says that something seems to be gnawing at the bone, sometimes that an enormous weight presses on a limited portion of the limb; at other times he feels a sensation of distention, as if the bone were going to fly in pieces; at other times, finally, it appears as if some one were boring through the bone or hollowing it out. Then there come acute, lacinating pains, which make him cry out, or an insupportable sensation of burning. These pains return every night in the subacute, and in some chronic forms; but in the acute, they are constant during a certain length of time, and have only exacerbations at night. Sometimes, after having lasted eight or ten days, and often more, they cease suddenly. This sudden cessation coincides with the appearance of a larger peripheral swelling, or of an evident sub-periosteal abscess. The appearance of this abscess or of this collection indicates the breaking down of the barriers which held in the inflammation and caused strangulation. This is what is seen in some cases of suppurating synovitis; while the synovial membrane resists, the pains are intense and continuous; as soon as it gives way, inter-muscular sinuses appear, but the compression is at an end and the pain disappears.

Different Clinical Forms of Spontaneous Osteitis.

I have already said that nothing is more variable than the clinical forms of osteitis. Although having the same situation, the same extent, and characterized by the same anatomical lesions, these cases present the most varied aspects; sometimes benign, sometimes grave, they are dependent upon the cause which has given rise to them, and to the infecting agent of which they are one of the manifestations.

Inflammation of Bone accompanying the Period of Growth.—The period of growth of the skeleton being the epoch of life in which most cases of spontaneous osteitis are developed, the name "osteitis of the period of growth" might be applied to the majority of inflammations of the bones which occur in children and adolescents: but, thus understood, the name would not signify anything by itself. We ought to reserve it solely for the osteitis which occurs without an appreciable cause, without any traumatism or local or diathetic source, which appears only associated with an exaggeration of the work of nutrition which is going on at a particular time in any part of the skeleton.

"Growing pains" have always played an important part in the popular theories of children's diseases, but they have not attracted much attention from pathologists, who have been led to deny them, or at least to interpret them differently. In fact, there is nothing so variable as these transient pains of which children complain. It is sometimes hard to locate them, and still more to determine their nature.

Nevertheless pains exist, which are vaguely referred to the joints, but which are really situated in the juxta-epiphyseal region, and which should be attributed to a transient hyperæmia of the zone of physiological proliferation. I directed my attention long ago to this point; and I have been compelled to recognize the good foundation of the popular belief which attributes these pains to growth itself. When children are intelligent enough to give an account of their sensations, they assign these pains to the juxta-epiphyseal regions; sometimes, however, they point out a part of the shaft more or less remote from the epiphyses; and in some cases—in the hip, for instance—they indicate the joint as the seat of pain.

These different seats of pain are explicable by what I have already said about the organs of growth of the bone. If the most active zone of physiological proliferation is found at the juxta-epiphyseal region, it must not be forgotten that under the periosteum, all along the diaphysis, there is a deposit, continuous although unequal in its different parts, of osseous layers for the increase in thickness. On the other hand, there are diaphyseal extremities, that is to say, juxta-epiphyseal regions, which are found included in the joint itself; and the hyperæmic process of which they are the seat may easily be confounded with a pathological process in the articulation; hence arises in these regions, in the hip, for example, an inevitable confusion of osteitis and arthritis.

Growing pains are usually apyretic. In the evening, after having played all day, or having been fatigued in one way or another, the child complains of more or less acute pains in the bones. There is no appreciable heat or swelling; sometimes a little heat. The child goes to bed, and the next day the pains are gone. At other times these pains continue several days, or at least return at different intervals, and then go off as they came. Finally, under other circumstances, the pains invade a number of joints simultaneously, or the same joints in the two limbs, and are accompanied by a more or less marked febrile movement. This transient condition is distinguished from ephemeral fever, with pains in the limbs, by the fact that the pains are here more acute, and that they are fixed in the juxta-epiphyseal parts. The mistaken tendency to attribute to growth the majority of the diseases of children, which prevailed at one time, has brought distrust on the theory of the pains and fever of the growing period. It cannot be denied, however, that these pains exist, with the characteristic of having a juxta-epiphyseal location; but the significance of the febrile movement which often accompanies them might form a subject for long discussion. Is it an independent febrile state, occurring accidentally, and coinciding with an increased growth in the skeleton? Or is it a fever having its source and cause in the organic process which takes place in the zones of growth of the bone?

What gives greater weight to the former theory, is that growing pains are often associated with fatigue, violent exercise, chilling, movements which produce juxta-epiphyseal strain; in a word, with all the causes which, carried a degree further, may produce a true inflammation of the bone. Acting in a slight degree, these causes induce slight hyperæmia, or a few tissue-lesions which are easily reparable; pushed further, and occurring in a subject predisposed to morbid processes by hereditary antecedents or alteration of the general health, they are the commencement of those forms of acute or chronic osteitis which we shall study hereafter.

There is scarcely a child which, in the course of its growth, has not had to complain of these pains, which are most frequently located in the lower limb, particularly above or below the knee; they are observed especially at the time of the sudden advances which occur in the period of growth, and which are evidenced, in some cases, by an increase in height of from twelve to fifteen centimetres a year. While more frequent in the lower limbs, they are also observed in the upper: at the upper extremity of the shaft of the humerus, the lower end of the radius, etc.

But, as I have just said, this exaggeration of the physiological fluxion to the zone of growth is not always limited to pain, and in many cases it is only the commencement of an inflammatory process which may have very grave consequences. Osteo-myelitis which ultimately assumes an infectious character often commences like growing pains, and parents often mistake the significance of these painful points; they neglect them, let the children walk, and afterwards see the outbreak of graver symptoms.

There is nothing so variable as the onset of these cases of osteitis, unless it be their subsequent course and the consequences which they entail. The grave and acute forms sometimes begin suddenly, with severe local, or with grave general phenomena; but sometimes they are preceded for several weeks by juxta-epiphyseal pains which return in crises, as if by exacerbation, and which pass off spontaneously, leaving only a little torpor in the limb. The pain having passed off, the child resumes his plays, but is easily fatigued, and remains for some time in danger of the most serious lesions.

It is under these circumstances, indeed, that a slight traumatism, a violent movement, a local or general chill (from lying on the grass or the wet ground), brings on the symptoms of acute inflammation, which may soon assume an unfavorable aspect as regards the general health, or may take on a grave character simply in respect to the local phenomena. The same occasional cause then may sometimes provoke an osteitis the gravity of which is proportioned to the severity of the local inflammation, sometimes an osteitis in which the local lesion is lost sight of in the gravity of the general symptoms. Let us endeavor to find the reason for these differences.

INFECTIOUS INFLAMMATIONS OF BONE.—Since Chassaignac, struck with the severity of the general symptoms in acute osteo-myelitis, gave this affection the name of *typhus of the limbs*, all surgeons who have written on inflammation of the bones have made the same observation, and have asked themselves what was the cause of this great gravity. Soon after Chassaignac, Gosselin showed the relation of this form of osteitis to adolescence. Struck with the anatomical disturbances produced at the ends of the long bones, he described the *epiphyseal osteitis of adolescents*, and dwelt upon its gravity.[1] At the same time Klose, of Breslau, described the same affection under the name of *separation of the epiphyses, or meningo-osteo-myelitis;* and various authors (Schutzenberger, Bœckel, Holmes, Giraldés) described it under the name of *phlegmonous or diffuse periostitis.* It has by others been designated as *infectious or malignant periostitis* (Volkmann), as *pseudo-rheumatic inflammation* of the bones and joints (Roser), etc. etc. The names of *acute osteo-myelitis*, *acute osteo-myelitis during growth* (Lannelongue) have also been given to it; Culot called it *acute medullitis.* Since 1860 I have taught the frequency of its juxta-epiphyseal origin, and it was described by Gamet, in 1862, under the name of *juxta-epiphyseal osteo-periostitis*, in accordance with the ideas which I already at that time held in regard to the seat of the primary lesion.

Without discussing the value of these names, which have all some truth in them, and which are applicable to individual cases, we must here study the nature of this acute osteitis, and not seek solely in the localization of the inflammation, the explanation of its gravity. The most important question is this: is the bone-lesion the expression of a general morbid state, of a pre-existing alteration of the blood? or is it the origin, the cause, the point of departure of this condition? The answer to this question is of the greatest importance in regard to treatment; for, as the bone-lesion is the cause or the effect of the morbid state, we should suppress it as soon as possible, or abstain from all interference.

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[1] Gosselin, Archives Générales de Médecine, 1858.

As numerous as have been the investigations of this affection during the last thirty years, no approach has yet been made to giving an exact demonstration of the problem. For some years prevailing views have led many observers to seek for a specific microbe. In France, Pasteur; in Germany, Lucke, Recklinghausen, Rosenbach, Kocher, Becker, and others, have published important works on this question. Micrococci have been described which have been regarded as specific; they have been found in the blood, and in the different tissues of the organism; but it has not been possible to cultivate them, or at least to reproduce, by inoculating them, an affection like that which furnished them.

The recognition of these microbes is so difficult, their differential characteristics are so slightly marked, that it would be premature to formulate an opinion from the evidence which we possess at the present time. Becker,[1] however, having injected a culture-fluid into animals in which he had just produced a traumatism of bone, succeeded in multiplying the micrococcus in this new soil, and found it constantly in the blood and pus. Pasteur had announced the analogy of the microbe of osteo-myelitis with that of furuncle. Kocher does not admit any difference between the micrococcus of osteo-myelitis and that which is found in the acute inflammation of wounds. However it may be as to the specific character of these micro-organisms, which we should not yet either reject or adopt, we shall find in our clinical study of the affection strong reasons to admit a primary infection.

In some patients, general phenomena open the scene: intense fever, delirium, and prostration. The case might be thought one of typhoid fever, and this error of diagnosis is so frequent that it is in medical wards that there is most frequently opportunity to observe cases of infectious osteo-myelitis. Sometimes, indeed, the patients succumb so quickly that there is hardly time to suspect the bone-lesion. This lesion is found at the autopsy, but it is of such slight extent that it cannot be considered as the direct cause of death. These cases seem to me to be rare, but they are met with nevertheless. Here is one which I have recently observed:—

A month ago my colleague, Dr. Laure, physician to *La Charité*, communicated to me the notes which he had collected in regard to a child, nine years old, who had died in three days of an infectious osteo-myelitis. Without any known cause, without any appreciable traumatism, this child had been seized with severe fever, delirium, dryness of the tongue, and then profound prostration. Looking for the signs of typhoid fever, M. Laure discovered a little doughiness around the right hip; while any movement of the part made the child cry out. He then diagnosticated an infectious osteitis of the hip, and thought of practising resection of the joint. The operation was postponed to the next morning, but in a few hours the child died. At the autopsy, which could not be made complete because of the opposition of the family, there were found in the hip-joint one or two spoonfuls of sero-sanguinolent fluid, slightly purulent. The synovial membrane was slightly injected, but there was no alteration of the head of the femur. At the bottom of the cotyloid cavity, there was a loss of substance a centimetre square, affecting the cartilage covering one of the pieces of bone which form the cavity. At the bottom of this loss of substance of the cartilage, the bone was bare and infiltrated with pus. The corresponding pelvic periosteum was thickened and infiltrated, but there was no sub-periosteal abscess. In the lung there was a small metastatic abscess; on the pleura there were three or four elevations resembling a commencing tuberculous eruption. The pus collected from the denuded portion of bone was inoculated upon two rabbits without result. The pus from the little metastatic focus in the lung was cultivated by M. Chauveau, and inoculated, equally without result, upon other animals.

In cases of this sort we can scarcely consider the bone-lesion as the starting-point and source of the general phenomena. There was an anterior morbid state which was sufficient, under the influence of a violent movement, a blow, or a fall, to lead to the formation of pus in a part of the bone subjected to a trifling traumatism. But then the traumatism could only be considered as the determining cause of the localization, and not as the origin of the morbid state.

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[1] Becker, Deutsche med. Wochenschrift, No. 16, 1863; Progrès Médical, 19 Janv. 1884.

But whence comes this morbid condition? In the majority of septic poisonings we see the door of entrance of the infectious agent; we know the wound which is the starting-point of the pyæmia. But here, in the absence of any wound, we are obliged to seek in the mucous membrane of the lungs or intestines the route by which the infectious germ may have entered. These are questions which are still very obscure, and which would lead us too far if we should attempt to discuss them.

Besides these primary septic intoxications, there are many cases in which, while admitting a general infectious state, a more important part must be assigned to the bone-lesion. If it is the first product of a general infection, it becomes a permanent centre of secondary infection. It is then the starting-point of pyæmic processes, of infectious metastases, which may successively attack various other parts of the skeleton and the different internal organs.

These two modes of infection present very great differences from a practical point of view. In the first case, all surgical intervention is useless; in the second case, on the contrary, suppression of the first focus of infection may, by preventing secondary infection, permit the patient to recover, and thus save his life.

The severity of the primary infection ought to regulate the conduct of the surgeon, and serve as the basis of his prognosis. But in the ignorance in which we are yet as to the nature of the infecting agent and the attenuations of which it is susceptible, we ought always to be very reserved in the presence of osteo-myelitis which is accompanied by typhoid phenomena.

Chassaignac made the prognosis of acute osteo-myelitis very gloomy. He thought that nothing but amputation of the limb could save the patient, and that this was the sole means capable of arresting the consequences. For a long while the majority of surgeons adopted these pessimistic views, and amputation was everywhere recommended. I have long opposed this despairing doctrine, and have shown that the prognosis of acute osteo-myelitis, with typhoid phenomena, is much less grave in the country, in healthy surroundings, than in large hospitals or in the populous and unwholesome quarters of large cities. We receive into hospitals the sequelæ of the infectious osteitis which breaks out in the country, among peasants living in healthy neighborhoods. These are those necroses of the whole or greater part of a diaphysis, for which patients come after some months to ask the assistance of our art. We scarcely ever see necrosis arising in our hospital patients. They are carried off in the course of infectious processes, or they succumb at a later period from chronic septicæmia, if the surgeon does not interfere by amputation or ablation of the bone.

Children or adolescents are sometimes met with who have had at the same time, or near together, five or six attacks of osteitis of large bones of the limbs.

I have, among others, had the care of a patient, who has had acute osteitis seventeen times, either in the juxta-epiphyseal parts of the long bones of the limbs, or in the flat bones (ilium, cranium); he had twice, within a few years, sutural osteitis of the bones of the skull. The majority of his attacks of juxta-epiphyseal osteitis have ended in the separation of small sequestra; he is now completely cured.

Infectious osteitis is seen especially during the period of growth of the skeleton; but it is sometimes met with after the consolidation of the epiphyses.

Apart from traumatisms, I have seen, in patients of thirty or forty years, a number of cases of suppurating osteo-myelitis of the tibia, humerus, etc., which occurred with the grave phenomena of osteitis of adolescence. In 1865 I resected the lower end of the femur in a man thirty-eight years old, in whom I found the epiphysis detached. The symptoms were ameliorated for several days after the operation, but the patient died on the tenth day from hemorrhage.

Separation of the diaphysis from the epiphysis in adults, although the whole of the connecting cartilage may have disappeared, is made possible by the persistent independence of the lamellar system of the spongy tissue; at any age, up to the most advanced, the trace of the connecting cartilage may be recognized. It is represented by an ossified line, which keeps its direction exactly, and which separates the longitudinal system of lamellæ of the epiphysis from those of the diaphysis. The circulation goes on unequally in these different parts of the bone; the epiphysis is less vascular, while the circulation is more active in the juxta-epiphyseal portion of the shaft. This is what makes the latter region always a seat of election for osteitis even in adults.

We have already seen how much reservation is necessary as to the nature of the agent which produces infectious osteitis, and even as to the mechanism of infection. The study of *post-febrile osteitis* shows, in fact, that there are numerous conditions in which multiple inflammations of the bones may be developed simultaneously or successively under the influence of general infection. All the eruptive fevers—measles, variola, and especially typhoid fever—may be followed by multiple osteitis, which comes on either at the time of evolution of the disease, during convalescence, or some time afterwards.

In these different affections there is an alteration of the blood which, during the period of growth, particularly predisposes to affections of the bones. In all times observers have pointed out the gravity of measles in children in this respect, and many affections of the bones are, in popular theory, referred to attacks of measles or other febrile affections in childhood.

These attacks of post-febrile osteitis differ very much in their course, and are of unequal severity. There are some which are benign; some are subacute, and some even chronic; while others are met with which are of the greatest gravity, which progress rapidly, invade successively different bones, and are from the commencement accompanied by septic and pyæmic complications.

This difference in course indicates a difference in nature, and, in certain cases only, an inequality of infection or a greater resistance of the soil in which the morbid germ may have its evolution. The forms of osteitis which are developed in the course of fever and without any appreciable occasion, are those in which infection plays the principal part. Those which occur during convalescence, or after recovery, are often produced by a slight traumatism or by cold. These causes, which would be insufficient in a healthy subject, cause juxta-epiphyseal inflammations in one weakened by disease, who is thereby made to offer less resistance to cold, and in whom, besides, the solidity of the skeleton is diminished, as much by the feebleness of the muscles as by the alteration of nutrition which the bone-tissue has undergone during the febrile period.

During convalescence, a fall, or a violent movement, may produce juxta-epiphyseal strains which cause those forms of chronic osteitis that develop slowly and are afterwards taken for scrofula. The same causes (traumatism, susceptibility to cold), in convalescents, lead to the development of tuberculosis, to which they may be predisposed by their hereditary antecedents. Under the same conditions, also, tuberculosis may develop rapidly, assume the character of an acute infection, and give rise to a multiple osteitis which progresses rapidly and secretly invades different parts of the skeleton, differing from pseudo-rheumatic infectious osteitis by the absence of acute pain, in spite of suppuration of the juxta-epiphyseal regions. In some cases I have recognized this form of acute tuberculous infection of the bones; in the future it will be advisable, in the diagnosis of cases of this sort, to search not only for the micrococci which are said to be characteristic of infectious osteitis, but also for the bacillus of tuberculosis. Whatever may be the results given by such an examination, which I have not been able to make as yet, because I have not lately had an opportunity to observe favorable cases, the acute and infectious form of osseous tuberculosis should be recognized.

If delayed post-febrile osteitis appears commonly in the subacute or chronic form, that which is contemporaneous with eruptive fevers may also have this character. During an epidemic which prevailed in Lyons, in 1874, I had several times occasion to open collections of pus which had formed in the course of typhoid fever, and which had not given rise to any acute pain. In these cases there was superficial periostitis, and, after the abscess was opened, cicatrization occurred without necrosis following.

In my investigation of juxta-epiphyseal strain[1] I noticed the slight adhesion of the diaphyses to the corresponding connecting cartilages in children who had died of eruptive fevers, and especially of hemorrhagic variola. Separation of the diaphysis took place upon the least effort, and the periosteum was less adherent to the bone than in the normal state. This condition probably exists more or less in all diseases of this category, and may continue for a certain time; this is one cause of the facility with which juxta-epiphyseal strains take place during convalescence from these diseases, and it furnishes an explanation of the chronic osteitis which may develop afterwards.

We know also that in a great number of severe diseases in children a considerable increase in the height of the patient is observed. Repose in the horizontal position and diminution of pressure cannot explain this lengthening of the bones. Auboyer,[2] who measured many children suffering with acute diseases, found an appreciable increase in height in only eleven out of sixty-two patients. In this connection we must take account of the congested state of the medulla, which has been observed by various observers (Busch, Neumann, Ponfick), and which may at any moment favor the proliferation of the connecting cartilages. Whatever may be the significance of this congested state in regard to growth, it is one of the causes which explain the frequency of juxta-epiphyseal post-febrile osteitis.

From the details which have been given, it is seen that, independent of the resistance of the individual, which cannot be appreciated beforehand, there are different elements which may intervene to explain post-febrile osteitis, and that if infectious agents may produce it, general alteration of the nutrition and the common causes of osteitis play also an important part in its etiology.

Rheumatic and Neuralgic Inflammations of Bone.—Until recently there has been little disposition to recognize a rheumatic form of osteitis, at least as a distinct affection and determinate morbid process. The articular lesions have masked those of the bone and have caused them to be overlooked. Adams, Cadiat, Ferréol, Gosselin, and others, have corrected this misunderstanding, and have called attention to rheumatic osteitis. Gosselin[1] has shown that the long bones may be the seat of osteitis of this nature without implication of the terminal joints. Cases of this sort are those which are most convincing, and which ought to settle the question. I have for a long time seen incontestable examples of rheumatic osteitis and osteo-myelitis, and I share entirely the views of Gosselin on the nature of this affection.

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[1] De l'entorse juxta-épiphysaire (Revue Mensuelle de Médecine et de Chirurgie, 1881).

[2] Thèse de Lyon, 1881.

Rheumatism of the bones is acute or chronic. The chronic form is the commonest, the acute form is the most serious. For a long time surgeons whose attention has been directed to this matter have been struck with the influence of cold upon inflammations of the bones. It has been noticed that syphilitic osteitis develops itself preferably in the superficial bones which are exposed to cold and external influences. But the analogy between rheumatic fever and the fever which accompanies acute osteitis has been equally noticed. Hence the name *pseudo-rheumatic*, given by Roser to the osteitis which constitutes so much of what is now known under the name of infectious osteitis. I have already spoken of this form of osteitis, and need not here return to it.

The existence of rheumatic osteitis is not to be denied when it occurs in certain circumstances which suffice to determine its nature; when it breaks out, for example, in a patient who has already had one or two attacks of acute or subacute articular rheumatism, and when it manifests itself under the influence of cold, without any traumatism, and especially when it is accompanied by, or follows, inflammation of the fibrous parts of the joints. It is most apt to attack the periosteum, and then it constitutes a superficial inflammation of the bone, which may pass off without leaving any permanent trace, but which sometimes gives rise to sub-periosteal ossifications or to permanent osteophytic excrescences.

Rheumatism may also attack the medulla and give rise to forms of osteitis which are painful, stubborn, and sometimes very hard to cure; but which may rapidly disappear after a certain time. The following is one of the most remarkable examples of rheumatic osteo-myelitis which I have ever had an opportunity to observe, and which have fixed my conviction upon this point:—

A lady, 51 years old, who had had in her youth slight attacks of acute or subacute rheumatism, was caught in the rain on the 7th of December, 1863, and walked for the distance of a kilometre[2] in the mud and water. She reached her home with her feet soaked. The next day she had swelling and acute pain in the anterior tarsal and tarso-metatarsal joints. For two nights she had a little fever. Eight days afterwards the foot had resumed its normal condition, but she had lancinating pains along the tibia, and especially in the interior of the bone. I saw the patient at this time. There was no perceptible swelling; there could only be felt, especially in the evening, a little heat along the bone. I prescribed blisters, leeches, and Dover's powder. The pains were slightly lessened during several days, but then they came back with greater severity, and, for eight months, in spite of the most active revulsives, they were the despair of the patient, who lost all sleep. At the end of this time the tibia had not undergone any notable increase in size; it had merely a slight arching, and on some days warmth, appreciable to the hand, along the inner face of the bone. At one period the pains assumed such a character that I spoke to the patient about the necessity of trephining the bone. She at this time went to consult Nélaton and Laugier, who diagnosticated an osteo-myelitis, and also spoke of trephining. The patient refused any operation and continued to suffer. She was better and worse for several months, then, in the month of June following, eighteen months after the beginning of the attack, she went to take the waters of Saint-Sauveur in the Pyrenees, and came back completely cured. All the pain in the tibia had disappeared after a few days of treatment, and the patient could walk as before. Suddenly, three months afterwards, in consequence of being chilled, the patient was attacked with an endocarditis which caused such grave valvular lesions that she died the following winter.

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[1] Clinique Chirurgicale de la Charité, 3e édition. Paris, 1878.
[2] [Nearly five-eighths of a mile.]

In this case, which appeared to me to be typical of rheumatic osteomyelitis, or rather medullitis, it is impossible to mistake the nature of the affection. In young subjects it might be possible to confound rheumatic osteitis with the osteitis of the period of growth. But, as I have already remarked, osteitis of the period of growth does not form a peculiar variety from the etiological point of view. A number of causes may bring it about, or at least provoke it, and in this respect chilling ought to be placed in the first rank. It is in these conditions that I have several times observed albuminous periostitis.

When, as is usually the case, rheumatism attacks the periosteum and fixes itself upon this membrane, it provokes, especially if the patient is young, a more or less pronounced swelling. It also provokes this hyperostosis secondarily when the medullary tissue is first attacked. I have seen a young man of 16 years, whose femur had reached a size apparently double that which was normal, in consequence of an osteo-myelitis which had lasted more than a year, and which only yielded to repeated sweatings.

In cases of acute or subacute rheumatic arthritis, a periosteal swelling may be found which extends more or less toward the middle of the bone, and which may give rise to a persistent increase in size or to peri-articular osteophytes.

As all forms of acute osteitis are painful and present characteristic nocturnal pains, that is to say, pains which recur at an almost fixed hour, it may be asked if it be worth while to make a separate category for neuralgic osteitis. All these divisions are doubtless a little artificial. But I shall give with Gosselin the name *neuralgic osteitis* to osteitis in which rebellious pains constitute the predominating characteristic of the affection, and are not accompanied by fever and infectious phenomena. Gosselin has seen it twice in the femur and eight times in the tibia, but has not observed it in other bones. I have seen it, independent of the tibia and femur, which are its most frequent seats, in the humerus, the fibula, the radius, the first phalanx of the thumb, etc.[1] Gosselin, having successfully trephined a number of bones which were the seat of persistent pains, and having found no pus, nevertheless cured his patients. He therefore advises trephining in these cases, which he calls false abscesses of bone. This relief of patients by trephining which has not disclosed any purulent collection, has been observed by a number of surgeons (Nélaton, Barrier), and I myself, in 1862, in the first case of the kind which I had ever seen, caused the pain to disappear, although I found in the centre of the bone only a little semi-transparent, grayish marrow, like a hardened jelly. The pains disappeared for several years, but the process of osteitis was not extinguished; the bone continued to become hyperostosed, and twelve years afterwards the patient was attacked with suppurative panosteitis, which caused his death from pyæmia.

I have several times observed the continuation of this process of hypertrophy in bones which I had trephined for rebellious pains, and in which I had not found pus. A young man whose humerus I trephined twice in 1869, had a considerable hypertrophy of the lower half of that bone in spite of the disappearance of the pains after the operation.

What is the cause of the pains in neuralgic osteitis? The relief afforded by trephining indicates that the cause is compression of the hyperæmic medulla. By freeing the medullary tissue from its hard and inextensible envelope, and by permitting it, by trephining, to dilate when it becomes the seat of physiological hyperæmia (in walking, in standing, or because of an elevated temperature), we can prevent or put an end to those pains which nothing hitherto has been able to assuage, or at least to make disappear. There are probably two mechanisms which may be invoked to explain these pains: compression of healthy nerve-fibres by the hyperæmic medulla, and compression of nerve-fibres which are themselves already affected with neuritis. But these histological examinations are so difficult and delicate, that I can cite only clinical arguments. In all cases one fact is certain, that is, that these pains cease all the better and sooner, the more completely the medulla is liberated, and the larger and more numerous are the openings in the bony wall.

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[1] Simon Perret, De la trépanation dans les abcès des os et dans l'ostéite névralgique. Thèse de Paris, 1876.

In searching for the deep collections of chronic osteo-myelitis which keep up those intolerable pains that slowly exhaust the patient, it is sometimes necessary to traverse with the trephine layers of condensing osteitis two or three centimetres thick. The piece removed by the trephine is then white, and dense as ivory. It must not be supposed, however, that neuralgic osteitis is characterized by condensation of the bone-tissue. This condensation is usual around old centres of necrosis; it is also seen in the slow forms of spontaneous or traumatic osteitis; but it is often absent. Sometimes, even, intense and rebellious pains are observed in rarefied, oily, fatty bones, into which the trephine passes easily, and in which neither pus nor sequestrum is found. In a number of such cases which I have seen, the trephine has been the only means of dispelling the pain. Several times, in rarefying osteitis, it has been only after tunnelling the bone (perforating it from side to side) that the pain has completely disappeared.

I have, however, observed some cases of painful osteïtis, with nocturnal and stubborn pains, notwithstanding the presence of a small fistulous track which allowed the pus to escape. But in cases of this kind I have been able to put an end to the pains, by substituting for these small openings a large one which prevented any retention. Once only have I observed a rebellious neuralgia in an open abscess. There was a cavity in the juxta-epiphyseal extremity of the radius, into which the probe passed freely by two openings. But simply touching the granulating membrane with the probe provoked acute pain. This membrane was the seat of a true hyperæsthesia. I removed it by enlarging the cavity, and submitted it for histological examination to my colleague, Prof. Renaut, who found in it an extraordinary new formation of the fibres of Remak. Except in this one case, I have been unable to assign any cause for the pain except strangulation; in open inflammation of the medulla similar symptoms are not observed.

Abscesses of Bone.—It is this strangulation which makes acute or chronic abscess of the bones so painful. These abscesses, which have been studied especially since the time of Brodie, are seen principally in the juxta-epiphyseal regions of the long bones, and not in the epiphyses, as might be believed from the expression *epiphyseal abscesses* which was applied to them by E. Cruveilhier. These abscesses are often a more or less remote consequence of osteitis which has suppurated at a previous period. They are explicable by the multiformity of the osteo-myelitis, and by the inequality of inflammation in different parts of the bone. They are often the result of a bi-polar osteitis, one juxta-epiphyseal extremity having suppurated and allowed the elimination of some sequestra, while the other extremity suffered a less degree of inflammation, which did not proceed immediately to necrosis, but which left behind a source of irritation which the usual causes of osteitis rendered active at a later period. Furthermore, these abscesses of bone, consecutive to osteitis, may be found along the whole length of the diaphysis, the central marrow having been replaced after the first inflammation by a spongy tissue of irregular structure and unequal density.

These secondary effects of osteitis may be observed a long time afterwards. In 1883 I trephined an old man of seventy-five years, who had had an osteomyelitis of the lower half of the tibia at the age of thirteen years, in 1821, that is to say, sixty-two years before. I made two openings with a trephine, and removed the bridge of bone between them with a gouge; and I found in the centre of the bone a collection of pus, in which was a small, longitudinal sequestrum, twenty-six millimetres in length, of compact tissue, which had required more than half a century to become separated and to provoke an appreciable inflammation around itself.

It is easy enough to diagnosticate abscess of bone when it is a remote consequence of osteitis. The persistence of pain, or, at least, its return at the same point, a projection in the bone at this level, persistent heat, and finally a little infiltration and redness of the skin, indicate the formation of pus and its progress toward the exterior. Some of these abscesses take a very long time to appear externally, on account of the thickness of the compact layer which separates them from the periosteum. When, however, there is pus inside the bone, this compact layer becomes medullized by degrees, is vascularized, and finally opens by a spontaneous trephining. But this spontaneous trephining requires months and perhaps years to be completed, if the surgeon does not intervene. The inflammation may cease and the pus be absorbed. This termination is possible in young subjects; and then a circumscribed cyst is formed. But if a new attack of osteitis occurs, the pains reappear, and persist until the opening of the collection, although they may stop again if no sequestrum nor pus has been already formed.

The tolerance of bone-tissue for the products of inflammation, and even of necrosis, is often indefinite in young subjects. There are found in bones formerly diseased, cystic cavities or limited spaces, more or less circumscribed, which are the relics of old osteitis. An aseptic sequestrum may persist indefinitely or disappear by erosion in the midst of medullary granulations. What proves this tolerance of bone-tissue for certain inflammatory products, is the slowness of evolution of some tuberculous and syphilitic collections, which, developed often without pain, persist indefinitely, and are only found accidentally at an autopsy.

These tuberculous collections are liable to inflame suddenly, and then to give rise to symptoms of acute osteitis; but they do not generally have the acuteness of the osteo-myelitis of which I have spoken above.

An important point to note in the evolution of these bone-abscesses is that often the pains, which up to a certain time have been very acute, suddenly cease. This is when the pus, by spontaneous trephining from within outwards, has reached the periosteum or is separated from it by only a thin, flexible, and depressible layer. As soon as the sub-periosteal abscess appears, the interosseous pain ceases; and still more if the pus, traversing an erosion or a vascular opening in the periosteum, can spread itself freely in the parosteal layers.

Bone-Inflammations from the Introduction of Poisonous Inorganic Substances; Phosphorus-Osteitis.—Osteitis produced by phosphorus was a very common affection thirty or forty years ago. Nowadays it is hardly ever seen, at least in France, and in all the countries in which the manufacturers of matches have adopted the use of amorphous phosphorus. At Lyons I saw some cases in the beginning of my practice, but for ten years I have not seen any. This affection was, a few years ago, the subject of numerous works among which I will mention those of Lorinser, Bibra, Trélat, and Haltenhoff. At first there was some hesitancy in recognizing the special action of phosphorus, and the phenomena were attributed to the impurity of the substance (Dupasquier); but the frequency of cases in match-factories convinced the different observers of the reality of the special action of the phosphorus itself. It was found that the majority of the affected subjects had already caries of the teeth and concomitant alterations of the alveoli; and it was generally believed that the vapors of phosphorus acted on the bone only through the solutions of continuity produced by dental caries and the suppurations to which it gave rise. But Trélat[1] cited four cases in which the teeth were perfectly healthy when the symptoms began, and Haltenhoff reported afterwards[2] a similar case. Bibra and Geist had previously endeavored to produce this form of necrosis experimentally in animals, and had found, in rabbits which were made to live in an atmosphere filled with the vapor of phosphorus, that necrosis of the jaw-bones occurred only in those whose teeth had been broken or whose maxillary bones had been denuded.

The action of phosphorus shows itself first in one or the other of the maxillary bones; in a single case Lorinser saw it begin in the malar bone. It is seen oftener in the lower than in the upper jaw. According to Trélat, in 167 cases the upper jaw was affected 74 times, and the lower jaw 93 times.

The affection begins with pain in the teeth and a painful swelling of the jaw. Sometimes, according to the observations of Lailler, the bone is swollen before the pains in the teeth attract attention. Then the gums are red and swollen, and the patient notices bloody spitting, etc. Soon the swelling of the jaw increases, and abscesses open upon the gums. The patient is then temporarily relieved; but as the osteitis is eminently progressive, if the patient continues exposed to the vapors of phosphorus, the manifestations only grow worse. The teeth loosen and fall out; the breath is fetid; pus is spit in greater or less abundance; the swelling of the face increases; and the patient presents symptoms varying with the progress of the inflammation to one or another region; the inflammation, starting from the maxillary, is propagated to a neighboring bone (palatine, malar, vomer) and sometimes further —temporal bone (Trélat), occipital (Haltenhoff). This affection is serious because of its spreading course when the patient cannot immediately escape from the cause which has produced it. Nevertheless benign forms have often been observed (Lailler), certain patients, without quitting their work, getting rid of their sequestra as fast as they separated. When the osteitis has attacked a great extent of one of the maxillæ, or several bones at once, it may become of great gravity because of the ceaseless absorption of toxic material which it causes. The patient poisons himself more and more by swallowing pus which is constantly decomposed by contact with the air and by mixture with food. To this poisoning he succumbs in the absence of opportune intervention.

An important question in the study of phosphorus-osteitis, is that of the anatomical lesions which it produces. It has been asked if this osteitis is characterized by special lesions, and if a special anatomical form corresponds to the specific cause which produces it. From what I was able to observe at the time when I saw cases of phosphorus-osteitis, I believe that it has no special anatomical form, and I do not believe that, if confronted with a maxilla which had been removed by resection, or by a sequestrum of the same bone, it would be possible to affirm whether the lesion had been produced by phosphorus or not. The changes in the bone-tissue, properly so called, and in the periosteal envelope, are in proportion to the progress and degree of the inflammation. I have, in recent years, studied from this point of view all the cases of necrosis of the maxilla which I have seen, and, in the absence of any possible influence of phosphorus, I have seen the different anatomical forms attributed to phosphorus-osteitis, such as periosteal osteophytes, disseminated necrosis, etc.

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[1] Nécrose phosphorée (Thèse d'agrégation). Paris, 1857.

[2] La périostite et la nécrose phosphorique (Thèse). Zurich.

Besides the removal of the cause which has produced and which maintains it, phosphorus osteitis requires no special treatment. The first thing to do is to remove the carious teeth, to cleanse the mouth with frequent washes, and to remove the patient from all emanations of phosphorus. When once the bone-lesion is freed from these irritating causes, it should be treated like other inflammations of bone, and the surgeon should be guided, especially in pressing cases, by the necessity for freeing the patient as soon as possible from the sources of infection which are introduced by suppuration of the maxilla. The antiseptic indication is the first to be fulfilled, and it is important to have it in view, not only in necrosis of the maxilla, but also in the osteitis which causes this necrosis. Therefore, I do not share at all the view of those who always recommend expectancy in phosphorus-osteitis. As soon as the patient suffers from absorption of pus, the surgeon should intervene, lay bare the parts which supply the pus, and extract them, whether they are necrosed or not. Necrosis is so slow to be limited in phosphorus-osteitis, that irremediable alterations of nutrition would be produced if mobility of the sequestrum were waited for. At the outset it is proper to act as in osteitis which comes on from various causes (cold, traumatism, eruptive fever, state of dyscrasia). These forms of osteitis may be arrested by early incisions or by trephining the bone. The surgeon is guided by the general principles of treatment of osteitis which I shall presently set forth, and which depend upon laying open the periosteum or medulla with the object of preventing necrosis.

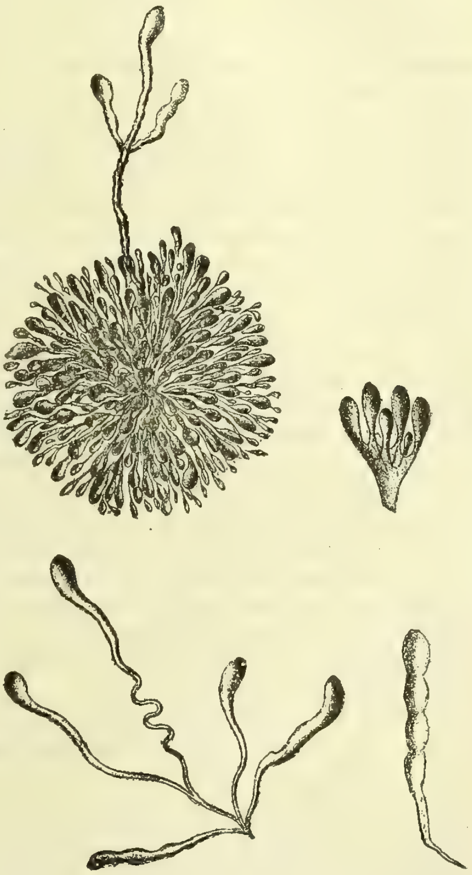
When once necrosis has taken place, whether the sequestrum be movable or not, he should intervene by a systematic operation which may permit immediate drying-up of the septic suppuration, the antiseptic indication being the most important. The chances for regeneration of the bone are a matter of less concern in such cases, since the advances of prothetic dentistry permit immediate reparation of the bony deficit. I would add, in regard to regeneration of bone in cases of phosphorus-osteitis, that it does not appear to me that there is anything peculiar in this affection. Cases have been cited in which, in spite of the persistence of the sequestrum, the periosteum has remained flexible and fibrous; and authors have cited others in which a regeneration, sufficient for form and function, has been seen after spontaneous elimination of the necrosed piece. Things go on as in all cases of suppurative periostitis or osteo-myelitis. According as the subperiosteal inflammation has been more or less destructive of the osteogenic layer, according as it has led to more or less rapid separation of the periosteum, the absence of regeneration will be noted, or the presence of a new formation on the deep face of the periosteum, uniting with it and forming the sequestral cavity of the old bone, which is destined to necrose and to be ultimately separated.

For my own part I have had occasion to observe a certain number of old cases of true phosphorus-necrosis, and I have seen the greatest differences in regard to bony regeneration.

In addition to phosphorus, other substances—arsenic, mercury, mother of pearl—have been accused of giving rise to specific inflammations of bone. But the action of these substances is still a matter of dispute, and what there is of positive in the published observations does not yet suffice to require the recognition of distinct varieties of osteitis.[1]

BONE-INFLAMMATION DUE TO THE PRESENCE OF PARASITIC ELEMENTS IN THE PERIOSTEUM AND IN THE OSSEOUS TISSUE; ACTINOMYCOSIS.—In 1877, a German veterinarian, Bollinger, declared the parasitic nature of certain tumors of the jaw in cattle, which until then had been assigned to osteo-sarcoma, or to chronic osteitis. He discovered in these tumors a peculiar fungus, with a characteristic shape, which Harz designated by the name "*Actinomyces bovis.*" This fungus is made up of branching filaments, club-shaped, resting on a pedicle of varying height, and presenting as a whole the appearance of an irregular umbel. Some time before Bollinger, two Italian observers, Perroncito and Rivolta, had discovered parasites in the osteo-sarcoma of cattle (from 1868 to 1873). Their observations remained incomplete, and failed to establish in a precise manner the relation between the parasite and the tumors in which they were found, but it was their observations which first indicated the presence of parasites in the sarcoma of cattle. In man, *actinomycosis* was first noted by Israël, of Berlin, and afterwards by Ponfick, of Breslau, and other observers (Fig. 1431). As early as 1845, however, Langenbeck had seen at Kiel, in a man who died of cachexia in consequence of vertebral caries, peculiar characteristics of the pus, which he could not at that time interpret as pertaining to a special disease, but which now appear to him to have belonged to actinomycosis.

Fig. 1431.



Fungus of actinomycosis. On the left is seen the parasite in a state of complete development; on the right one of the terminal gonidia with a varicose appearance; on the left, and below, filaments arranged in an umbel; on the right, and above, an isolated filament with a dentated appearance. (After Ponfick.)

This affection has not yet been observed in France. For myself, I have never seen it, and all that I shall say about it is only a *résumé* of works published abroad upon the subject.

Since the case of Israël, there have been published twenty-seven cases observed in man.[2] But in the majority of these, the initial lesion was in the lungs and soft parts. These cases are of only secondary interest from our point of view; some facts have been observed, however, which ought to be mentioned in connection with osteitis, because the presence of actinomycosis characterizes the bone-lesion, establishes its individuality, and determines its nosological position. In a number of cases the lesion has begun as a simple dental caries, but has been followed by abscesses or tumors of the jawbone which have necessitated scraping or resection (Partsch). What characterizes the disease microscopically is the presence of small yellowish nodules on the unulcerated tumors. These nodules resemble miliary tubercles. If they are opened, pus escapes which contains yellowish granules, resembling agglomerations of the powder of lycopodium. These granules are sometimes soft, like tallow; sometimes resistant in consequence of calcareous infiltration. They are nothing but colonies of the actinomycetes.

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[1] See Art. Syphilis, Vol. II., *supra.*

[2] Bricon, De l'actinomycose (Progrès Médical, 1881).

The gravity of this affection depends upon the propagation of the parasite by the channels of the circulation. It invades the lung and then spreads in different regions, and especially in the ribs and spinal column. The commonest lesion is vertebral osteitis. Suppuration of the bones of the limbs has not been observed.

The course of this affection is essentially chronic, although it may give rise to some acute phenomena. The treatment should consist in the extinction or removal of the nests of the parasite. At the beginning, when the parasite is still in the jaw and has not infected the economy, there is a chance to arrest its progress. In one case Partsch practised resection of the maxilla.

Thus far the cases have been too few to make it possible to determine the characteristics which may enable one to diagnosticate at the beginning the osteitis of actinomycosis; but hereafter, in the presence of chronic suppuration of the maxilla, of the ribs, or of the vertebræ, the pus should always be examined microscopically and searched for the parasites.

The origin of actinomycosis is as yet unknown; it is probable that the fungus is derived from vegetables which both animals and men use for nourishment. Its contagiousness has been demonstrated by Rivolta. Numerous attempts have been made to cultivate the parasite and to study the conditions of its existence and propagation. "The first attempts at inoculation by Peroncito, Harz, and Bollinger, were without result.[1] Ponfick and Zahn were at first no more successful, but Zahn finally reproduced, by inoculation and by insertion under the skin or in the peritoneal cavity, tumors of the same type in two calves and one cow. According to these experiments, the period of incubation varies from 40 to 114 days." Israël has succeeded with dogs.

TREATMENT OF BONE-INFLAMMATIONS.

The treatment of acute inflammations of the bones ought to be conducted on the same general principles that guide us in the treatment of abscesses; in spite of the special indications which their structure suggests, the bones should be treated essentially like the soft parts. When an inflammation commences, we should endeavor to abort it and prevent the formation of pus. When pus has formed, it should be let out as soon as possible by incision of the tissues which retain and imprison it. Whether the pus be under the periosteum or in the medullary canal, it is proper to go down to it, and to give it the freest exit possible.

The treatment of osteitis is first of all subordinated to its nature and degree. There are forms of osteitis which may be arrested at the outset by rest, blood-letting, revulsives, and calomel internally (rheumatic osteitis, osteitis of the growing period, osteitis of traumatic origin). There are others which go on in spite of all the measures which may be employed

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[1] Longuet, L'actinomycose (Union Médicale, 1884).

(infectious osteitis). We should begin by using local and general antiphlogistics when an acute inflammation attacks one of the bones of the limbs, and especially when it manifests from the beginning a certain degree of acuteness. In adolescents an application of leeches, followed by a purgative dose of calomel and then by mercurial inunctions, will sometimes succeed in removing the evil. But, if pain persists, if fever comes on, if the periosteum and the parosteal layers are the seat of a painful and progressive swelling, and if the terminal joints are threatened, it is necessary to act vigorously and not to rely too much on medical treatment, notwithstanding its frequent efficaciousness in the period of onset.

When remittent intra-osseous pains, with nocturnal exacerbations, are accompanied by fever and general disturbing phenomena, the surgeon must go to meet the inflammatory focus, and not wait until fluctuation indicates the formation of an abscess. He must make an incision down to the bone, through the periosteum, and must do it without hesitation, as soon as the diagnosis of acute osteo-myelitis or periostitis can be made out. The only rule to follow is to intervene as soon as possible by relieving the strangulation of the periosteal sheath, or by trephining the bone, that is to say, relieving the strangulation of the medulla. By acting thus, one may abort threatening inflammations, which by a short delay would have brought on necrosis and would have exposed the patient to pyæmic complications. These free incisions of the periosteum, practised methodically, in case of bones deeply situated and surrounded on all sides by soft parts, constitute a practice which I cannot too strongly recommend, as exploratory incisions in doubtful cases, as liberating incisions in cases in which the violence of the pain indicates strangulation of the inflamed tissues. If exit be given to a clear, ropy, non-purulent fluid, such as is found in the beginning of albuminous periostitis, we should stop at this incision, insert a drainage-tube going down to the bone, and dress the wound antiseptically. If the liquid contain oily drops, if it be clear, we should not go beyond the periosteum; we should wait. The periosteum may become reattached, and the medullary inflammation be resolved. Nevertheless this aggravates the condition, and makes it to be feared that serious manifestations may appear afterwards, due to suppuration of the medulla.

In grave cases one should commence with incisions into the periosteum. Sometimes they suffice to stop the pain and to arrest the symptoms, even when the inflammation is central and evidently of medullary origin. But there are circumstances in which it is necessary to trephine at once, and to open the medullary canal freely; this is when there is already pus in the interior of the bone.

Trephining the bone in osteo-myelitis, which was practised by J. L. Petit and recommended by Van Swieten, was until very recently an exceptional operation. In 1838, Morven Smith published in America a series of cases favorable to trephining in acute osteo-myelitis,[1] but in spite of these examples and the cases of Brodie, Stanley, Nélaton, Gosselin, and Bœckel, this operation was seldom practised.

In 1876, in a memoir read at the Academy of Sciences of Paris,[2] I called the attention of surgeons to the multiplicity of the indications for trephining in inflammations of the bones, and I recommended this operation in all painful forms of osteo-myelitis. "Trephining the bone," I said, relying upon the results of operations which I had practised since 1861, "is an operation applicable to all forms of osteo-myelitis, the predominant characteristic of which is intense and stubborn pain. It is also applicable in some cases to acute osteo-myelitis with grave general symptoms, as a means of aborting the inflammation. These intense and stubborn pains are not peculiar to a single variety of osteo-myelitis. The neuralgic character accompanies the most diverse lesions of the medulla, either apyretic or febrile, and it is the result of strangulation of the inflamed medulla by the bony walls which surround it."

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[1] American Journal of the Medical Sciences.

[2] De la trépanation dans les diverses formes d'ostéo-myélite (Comptes Rendus de l'Acad. des Sciences, 14 Août, 1876).

If it is necessary to go in search of the pus, in cases of intra-osseous abscess in which the diagnosis rests upon rational symptoms alone, still more is it proper to give exit to it when incision of the periosteum, permitting examination of the bone, reveals a spongy tissue infiltrated with pus, or when, on the other hand, the signs of retention have not yielded to the periosteal incisions. Trephining the denuded spongy portion is the best way in such cases to put an end to the retention of pus, and to the infectious phenomena of which it is the cause. The diaphysis is sometimes found separated from its connecting cartilage, and pus accumulated between this cartilage and the layer of spongy tissue which is next to it. This is what is seen in juxta-epiphyseal osteitis which has begun exactly at the junction of the diaphysis and the cartilage. But, in spite of this separation, the opening of the purulent collection will not suffice to put an end to the strangulation of the medullary tissue. The pus cannot flow freely, and the medullary cells must be opened through a certain extent to facilitate its escape; and if there is separation of the periosteum higher up, corresponding to already necrosed portions of the diaphyseal sheath, the trephine should be used at this point in order to penetrate to the central canal of the bone.

When the surgeon then intervenes at the outset, he may be content with opening the periosteum freely; but he must not hesitate to go even to the medulla, if infiltration of the spongy tissue, and a gray, dull, non-vascular appearance of the compact tissue, bathed in pus, indicate necrosis of the diaphysis. In such a case pus will be found in the medullary canal, and its evacuation will be the only means of bringing to an end the phenomena of infection, and of preventing more extensive necrosis. In a word, it is necessary always to be guided by this idea, that the bone-tissue must be treated like the soft tissues, and to penetrate to every point where pus may be suspected to be shut up. One opening with the trephine will not be enough in central osteo-myelitis of the large bones of the limbs; several must be made along the bone; and, if the arrangement of the parts permit, the bone should be perforated from side to side, so as to prevent all stagnation of the pus.

These trephinings do not cause necrosis; on the contrary, they constitute the best means of preventing or limiting it, and may obviate the necessity for total extirpation of the bone, or for amputation of the limb.

Chassaignac, as I have already mentioned, extolled amputation of the limb as the only rational mode of treatment in acute suppurative osteo-myelitis. For a long time these ideas were dominant in science, and they have had too many advocates among surgeons. Amputation appeared to them, indeed, the best means to rescue the patient immediately and definitively from the pyæmic infection which threatened him. And yet, formerly at least, the successes of amputation practised when the symptoms were acute, were very rare.

At the beginning of my practice, when I had not the same confidence that I have to-day in trephining or in simple ablation of the diseased bone, I did a certain number of amputations of this sort, and I saw almost all of my patients perish, either from a continuation of the original infection, or from pyæmia resulting from the amputation. In these cases the patients are especially predisposed to this affection, and they often succumb to true pyæmia, whether subjected to amputation or treated by incision of the abscess.

Nowadays amputation should be but rarely practised; trephining or total ablation of the diseased bone will save limbs which formerly were sacrificed. Everything depends upon the extent of the lesion, and upon the number of joints invaded; if several bones are attacked, with their contiguous joints, in different segments of the same limb; if the multiple joints of the foot and of the hand are invaded at the same time as those of the elbow and knee, or if, on the other hand, the soft parts are so burrowed by the purulent deposits that the limb resembles a sac full of pus, amputation becomes necessary. But if a single one of the large bones of the limbs be attacked, even if it be affected with panosteitis, that is to say, with total inflammation of the bone, and suppuration of the terminal joints, it may be removed. For, by practising this operation by the subperiosteal method, an operation will be done which is not usually graver than an amputation. Much more, if a pandiaphysitis be met with, which has left intact the terminal joints, one should save the limb and put a stop to infection by total ablation of the infecting centre, that is to say, by ablation of the portion of bone of which the medulla is infiltrated with pus.

Sub-periosteal ablation of an inflamed bone, done before the diffusion of the pus through the soft parts, will doubtless always be a serious operation; but with antiseptic dressings it should be attempted much oftener than in the past, especially with children in whom we may hope for regeneration of the bone from the periosteum which has been saved. In the adult, amputation offers greater advantages.

I can give here only general rules. Everything depends upon the importance of the diseased bone, and upon the orthopædic or functional result which may be obtained by saving it. Total ablation of a femur or of a humerus ought never to be undertaken except after failure of multiplied trephining of the bone, or when the sub-periosteal and intra-medullary lesions are such that the whole of the bone is certainly destined to necrosis. And even in the latter case, one ought to try first to put an end to the septic complications by local disinfection, by means of chloride of zinc or other metallic salts suited for coagulating the contents of the medullary canal, or for preventing all subsequent decomposition. By permitting the bone thus rendered aseptic to detach itself, its regeneration is better provided for than by removing it at once. It is very rare to have to remove the whole of a bone. Usually when both terminal joints are affected, the infectious state is so well marked that it contra-indicates any operation. Bockenheimer[1] successfully removed the whole of the femur from one joint to the other. I have never had occasion to do an operation like this. The cases to which the method of subperiosteal extraction is specially applicable are those in which a part of the diaphysis is affected, with one of the corresponding epiphyses; that is to say, the cases in which there is suppuration of one articulation, and in which this is accompanied by osteo-myelitis of a greater or less length of the bone.

When inflammation has started in an epiphysis, it remains limited to it for some time, or else speedily invades the corresponding joint, according to the relations of the particular epiphysis with the articular cavity. There are some epiphyseal inflammations which cannot exist without concomitant arthritis, as in the head of the femur or radius; there are others which may remain some time without provoking arthritis, as in the lower end of the femur, the epiphyses of the tibia, etc.; these epiphyses are partly extra-synovial and partly intra-synovial. According as the inflammation begins in one or the other of these parts, the joint remains unattacked for a longer or shorter time. When once the articulation is invaded by pus, epiphysitis can scarcely be cured except by resection.

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[1] Deutsch. med. Wochenschrift, Nos. 50 und 51, 1878.

Juxta-epiphyseal inflammations themselves are subject to the same considerations. Certain juxta-epiphyseal extremities are either altogether intra-synovial, as the neck of the femur, or partly so, as the upper end of the forearm; hence the necessity for resection of the joint when suppuration invades them.

As suppuration of the joints singularly aggravates the prognosis of osteitis, it is necessary to make every effort to prevent it. The best means of doing this is to interfere early, and to try to arrest the osteitis by making free incisions in the periosteum and by trephining into the medulla. If there are infecting forms which progress with a rapidity which overturns all our calculations, the majority of osteo-myelitic inflammations do not immediately invade the whole of the bone, and there is time for intervention. I recommend all the more urgently early interference, because nowadays, with antiseptic dressings, an exploratory incision, made methodically down to the periosteum, is applicable to the majority of cases of osteitis. When once the diagnosis of osteitis is established, it is not possible to interfere too soon in the acute forms. To wait for suppuration, as there is too much tendency to do in accordance with the old ideas, is to expose the patient to all the infective complications of medullary suppuration, and to invasion of the neighboring joints.

We should not wait for suppuration, we should anticipate it. We should, I repeat, decide all the more promptly to intervene since pyæmia is no longer as it was formerly, before the era of antiseptic dressings, the result of laying bare the medullary tissue. We should especially decide to act quickly in cases of old, recurrent osteitis, when local heat, violent pain, and fever, indicate a return of the osseous inflammation. Trephining at the painful point will arrest both the patient's pain and the accompanying symptoms.

It is not possible to attach too much importance to these remains of acute osteitis, which are always ready to become the point of departure of a new outbreak, and which are seen especially in subjects whose osteitis has been cured, or has seemed to be cured, the first time, by spontaneous trephining or by the discharge of a few small sequestra. There are cases of this sort which are never definitively cured until one decides to scoop out large channels along the whole length of the bone, from one extremity of the diaphysis to the other. If the openings are made too economically, centres of osteomyelitis are left, with or without vascular sequestra, which will show themselves at a later period under the influence of fatigue or cold, and which will necessitate a new intervention. Trephining, or, in other terms, scooping out large openings which penetrate into the bone, is most frequently done without the assistance of the ordinary trephine, in osteitis of the spongy tissue. The cutting gouge, that is to say, a gouge cutting on its lateral borders, suffices for excavating the necessary channels in inflamed spongy bones. Further choice of the necessary instrument may be guided by the shape, the thickness, and the hardness of the bone. The small trephines which Laugier long ago employed for blood-letting from the bones, are often very useful in central osteitis as exploratory instruments, to ascertain the contents of deep collections.

INFLUENCE OF OSSEOUS INFLAMMATIONS ON THE GROWTH OF BONES.

Certain changes of form and volume which the bones may undergo in acute or chronic inflammation, have long been recognized; but it is only recently that search has been made for the cause of these changes, and that the question has been asked why inflamed bones remain shorter than their congeners in some cases, and under other circumstances assume larger proportions. My experimental researches, while enabling me to determine the laws of physiological growth, have also demonstrated the laws of pathological growth; and we are able to-day, by studying the seat and duration of inflammation, to know beforehand what disturbance it will bring to the development of the organ.

Every persistent irritation of a diaphysis, whether periosteal or medullary, is manifested in a young patient by an exaggerated growth of the part. The bone is more or less hypertrophied, that is to say, increased in length and thickness, whenever the irritation has been intense enough to propagate itself gradually to the periphery and to the extremities of the diaphysis, without however causing destructive suppuration. When a bone is irritated by lacerating the periosteum, by breaking up the medulla, or by introducing foreign bodies into it, there is soon observed sub-periosteal hyperplasia associated with abnormal lengthening. When a bone is denuded of its periosteum, this bone does not increase in thickness, because the elements of increase in this direction have been removed; but it increases in length.[1] This increase in length is not due to interstitial growth; it is due to hyperplasia of the connecting cartilage, the cellular elements of which have become more prolific. To demonstrate this, it is only necessary to fix pegs at certain distances from each other, in the diaphysis and the terminal epiphyses, and to cause in any way, independently of the action of the pegs, a continuous irritation of the bone. It will then be seen that the pegs in the diaphysis have not changed their relations to one another, but that the pegs in the epiphyses have been respectively separated from the nearest peg in the diaphysis. The excess in length is produced at the position of the connecting cartilage, and by its means; for if it be excised, the growth of the bone will be cut short.

It will not do, however, to absolutely deny the occurrence of interstitial growth in inflamed bones. I have seen, rarely it is true, but I have seen, nevertheless, a little growth in inflamed bones in adults; and Poncet has mentioned a lengthening of fifteen millimetres in the humerus of a syphilitic woman. But this lengthening is so slightly marked that it may be neglected in the majority of cases.

Inflamed bones in the adult may acquire greater thickness, by means of the newly formed subperiosteal layers which may be deposited at any age under the influence of irritation of the periosteum. But when once the connecting cartilages are ossified, they cannot increase in length, unless in exceptional cases in which the bone-tissue has changed in structure and in consistence under the influence of slow and chronic inflammation.

Inflammation of the periosteum and medulla is progagated to a distance; and when it attacks the connecting cartilage it excites greater and more prolific activity of its cells. But if this transmitted irritation, which I call "indirect irritation," is productive in the matter of growth, the same is not true in regard to direct irritation, or irritation acting directly upon the tissue itself. This kind of irritation, instead of increasing the activity of growth in the bone, and the formation of bone-tissue by the cartilage, produces an opposite effect. It disturbs the process of ossification, sometimes hastening, but oftener retarding it. In every case it has the effect of diminishing the production of bone. In consequence of crushings or of multiplied incisions of the cartilage, there are formed cicatrices in the middle of the cartilaginous tissue, which remain fibrous for a greater or less time, and which hinder the evolution of the series of cartilaginous cavities which remain healthy. It is only in case this direct irritation is slight and not destructive, that it has no unfavorable influence. If the irritation be intense, if it go on to partial destruction of the connecting cartilage, then it causes an arrest of growth proportional to the number of cells destroyed. This is what happens in osteitis which is developed exactly in the position of the cartilage, and which always alters its tissue more or less. In some cases the inflammation passes into the epiphysis, going through the cartilage, which becomes necrosed; and then the result is an almost absolute arrest of growth.

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[1] Traité Expérimental et Clinique de la Régénération des Os, t. i. ch. v. et xii.

From this it is seen that the seat of inflammation in a bone explains the apparently contradictory effects of osteitis upon its growth. An inflammation seated in the centre of the diaphysis, or even in the spongy part of the bone, but far enough from the cartilage not to bring about its separation by pus, and still more its destruction, will be followed by lengthening of the bone. An inflammation, on the contrary, situated at the limits of the cartilage, which brings about partial or complete destruction of the normal spongy layer, or even of the whole thickness of the cartilage, by disintegration or by necrosis, will be followed by more or less marked arrest of its growth in length.

The excess of growth in bones affected with spontaneous or traumatic osteitis, may amount to seven or eight centimetres in a bone like the tibia. Usually the difference is less, lengthenings of two or three centimetres being the most common. These are observed in adolescents who suffer from a persisting remnant of an osteitis which has occurred some years before. Persistence of a sequestrum incarcerated in the centre of the diaphysis, or of a simple patch of osteo-myelitis, is enough to produce it, although the patient no longer suffers pain, or at least acute pain. A slow and silent work is going on which produces its effect upon the zone of physiological proliferation, and which finally betrays itself by an increase in length and thickness.

Hypertrophy in length does not take place equally in all cases of osteitis. It varies with the end of the bone attacked by inflammation. I showed, in 1861, that bones did not grow equally at their two ends. There is in each bone one extremity which contributes more than the other to the increase in length. By inserting leaden nails in the different bones of young animals, I found that this inequality of increase at the two ends began at birth and continued during the whole period of growth. It was not due then to the different epochs for union of the epiphyses, as might have been supposed. The difference in the time of union of the epiphyses is of little importance in explaining the inequality of growth. The earliest union does not take place until growth is about to cease, and the continuation of growth by the remaining cartilage is, on that account, of little importance.

In reality, there is a great difference between the two extremities in regard to growth; and, without being able to formulate it precisely for man, it may be said that in certain bones, as the radius and ulna, for example, increase is at least four times as great at the lower as at the upper end. In the femur, growth at the lower end is about three times as great as that at the upper end, after the age of four years.

My experiments have led me to the following conclusions in regard to the growth of the large bones of the limbs:—

In the same limb, the bones of the principal segments are in an inverse relation, and when the upper and lower limbs are compared, the analogous bones are in an inverse relation to each other. In the upper limb, the humerus grows in an opposite manner to that of the radius and ulna. The former grows most markedly from above; the latter especially from below. While the humerus grows principally from above, the femur, which is its analogue in the lower limb, grows chiefly from below. The radius and the ulna grow chiefly from below, while the tibia and fibula grow a little more from above.

From this a formula may be derived for the large long bones of the limbs.

In the upper limb, in the bones of the arm and forearm, the extremities distant from the elbow grow the most.

In the lower limb, in the bones of the thigh and leg, the extremities at a distance from the knee grow the least.

The relation which I have already noted between the activity of physiological growth and the frequency of neoplastic processes, should lead us to study the influence which may be exerted by inequality of growth in the two extremities of the bone upon the seat of election of such processes. Long ago[1] I showed that the end of a bone which takes the most active part in its growth, is also the seat of election for neoplastic lesions, such as benign or malignant tumors. The same relation exists with regard to inflammatory lesions, but it is much less striking. The rule seems even to have quite a number of exceptions. This depends upon the fact that inflammations of the bones are often caused by cold, and especially by traumatisms, such as juxta-epiphyseal strains, repeated frictions, and contusions of the bones, and that these latter causes act more especially in certain regions, such as the knee and the ankle, so as to set up inflammation exclusive of any special predisposition. Here, moreover, are some statistics which show what relations exist between the law of growth of the long bones of the limbs and the seat of neoplastic and inflammatory lesions.

In by far the greater number of cases neoplastic lesions are situated in the extremity of election for growth in length. In fifty-six cases which I have gathered at random, as they came under my notice, I have found the following proportions for the seat of neoplasms in the large bones of the limbs:—

Femur,	24 cases	Upper third	3
		Middle third	2
		Lower third	19
Tibia and fibula,	16 "	Upper third	10
		Middle third	3
		Lower third	3
Humerus,	10 "	Upper third	7
		Middle third	2
		Lower third	1
Radius,	4 "	Upper third	0
Ulna,	2 "	Lower third	6

The seat of election for these tumors corresponds, then, exactly with the seat of election for increase in length; they are the lower end of the femur, the upper end of the tibia and fibula, the upper end of the humerus, and the lower end of the radius and ulna.

The same relation exists for spontaneous osteitis, but it is not so striking; because, as I have said, the frequency of occasional causes of osteitis in certain regions counter-balances physiological predisposition. Repeated traumatisms and the action of cold will set up inflammation preferably in that part of the bone which is least active in growth, if the region of election for growth is by its situation less exposed to the influence of those causes.

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[1] Mémoires de la Société des Sciences Médicales de Lyon, 1863.

The lower end of the femur is the seat of osteitis much oftener than the upper end; this corresponds with the law of growth. But in the tibia and fibula the case is different; the figures are about equal (40 to 42) in the tibia, with a slight advantage in favor of the lower end. It is true that growth, although more marked at the upper end, probably does not much exceed, in man, that which takes places at the lower end. In the fibula the exception is more striking, for the lower end was much oftener the seat of osteitis in the series of cases which I have examined.

In the upper limb more numerous exceptions are found. In the humerus the upper extremity was attacked 13 times, while the lower extremity is noted 12 times. This is very little more at the upper extremity; and yet, according to my calculations, which, it is true, are only approximative in regard to man, growth from above is four times greater than growth from below; but the fact that the elbow is more exposed to blows and to cold, changes this relation by increasing the importance of the occasional and determining causes. The radius and ulna, which are much more frequently attacked at their lower end, show better the difference which might *a priori* be expected on account of the marked predominance of growth at the lower extremity.

Spontaneous osteitis is much more frequent in cold and wet countries. It is hard to say in what proportions; for hospitals, where a large number of these cases are seen, receive them from all quarters, and statistics permit only approximative calculations. At any rate, this affection is more common in the north than in the south.

By analyzing 305 reports of cases of osteitis collected in my service at the Hôtel-Dieu, M. Mondan, Chief of the Clinique, obtained the following particulars in regard to the age of patients suffering from osteitis:—

The disease began:

Under 10 years	37	times.
Between 10 and 20 years	166	"
" 20 and 30 years	51	"
" 30 and 40 years	16	"
" 40 and 50 years	10	"
Above 50 years	7	"
Age not mentioned	25	"
Total	312	"

This table shows the frequency of osteitis between 10 and 20 years, but might lead to error in regard to the number of cases of osteitis below 10 years. I ought to point out that the proportion changes in hospitals in which patients of all ages are received indiscriminately. At the Hôtel-Dieu of Lyons, it is exceptional to receive a patient less than 12 years old; on account of which a large class of patients is omitted from our calculations. Still more does this proportion differ for the early ages in hospitals, in which only children below 15 years are received.

Lannelongue gives the following figures:—[1]

Under the age of 5 years	9	cases.
From 5 to 10 years	17	"
From 10 to 15 "	41	"
From 15 to 20 "	30	"
1 case 21 years, 1 case 22, 1 not indicated, .	3	"
Total	100	"

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[1] Ostéo-myélite pendant la Croissance.

In regard to the seat of osteitis, an analysis of the cases gathered in my service at the Hôtel-Dieu gives the following figures for the large bones of the limbs:—

Femur	Upper third	22	95
	Middle third	15	
	Lower third	58	
Tibia	Upper third	40	124
	Middle third	42	
	Lower third	42	
Fibula	Upper third	5	18
	Middle third	2	
	Lower third	11	
Humerus	Upper third	13	30
	Middle third	5	
	Lower third	12	
Radius	Upper third	1	11
	Middle third	3	
	Lower third	7	
Ulna	Upper third	4	13
	Middle third	2	
	Lower third	7	
Total			291

In the statistics of Sézary the different bones were affected in the following order:—

Tibia	56 times.
Femur	47 "
Humerus	10 "
Fibula	3 "
Radius	2 "
Ulna	1 "
Total	119

Lannelongue reached the following results:—

Femur	34 times.
Tibia	23 "
Fibula	2 "
Humerus	5 "
Radius	2 "
Total	66

In regard to sex, I find in my own observations, among 294 cases of osteitis:—

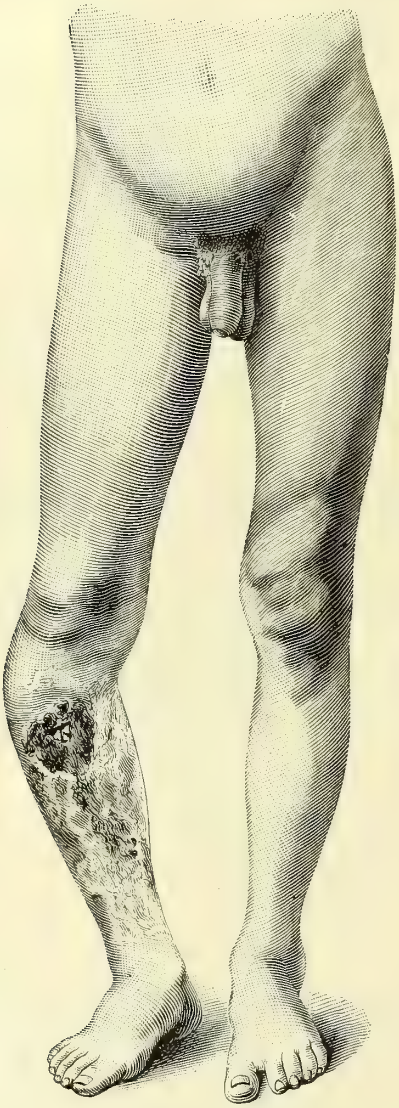
Females	47
Males	247
Total	294

This proportion of osteitis in men and women does not seem to me to be exact; the ratio of 1 to 5.2 is too small. That it should appear in my statistics, is explained by the fact that for three years my service did not include women. I should think it to be really about 1 to 3. At any rate, osteitis is much more common in males than in females.

Osseous inflammations produce disturbances in the growth of bones not only by exaggerating or repressing their development, but also by causing curvatures, deviations, and flexions, which may be very annoying from a functional, and moreover very disfiguring from an æsthetic point of view.

Juxta-epiphyseal osteitis causes loosening of the diaphysis, which leaves for a while a little mobility between the diaphysis and the epiphysis. At a certain time there is at this point a sort of articulation, an amphiarthrosis,

Fig. 1432.



Separation of the upper juxta-epiphyseal extremity of the diaphysis of the tibia from the corresponding epiphysis. Inclination of the leg inwards.

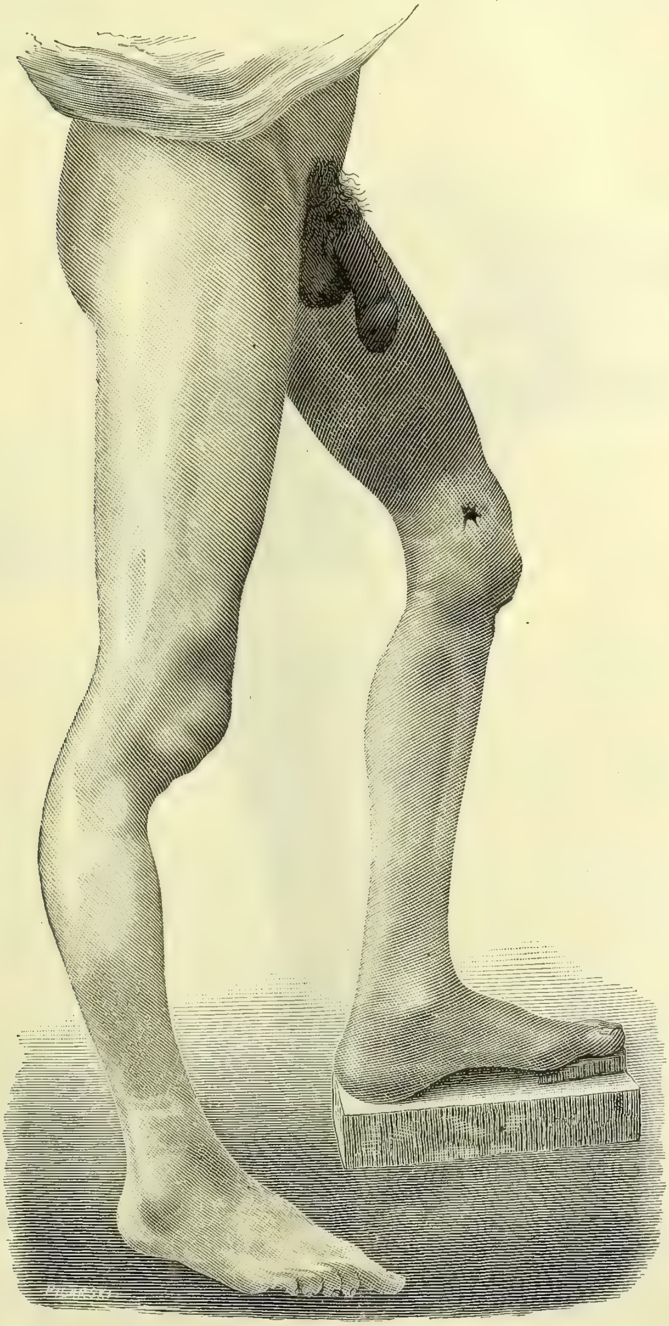
which does not permit extensive motion, but which permits the separated parts to slide one upon another, either under the influence of the weight of the body, or under the influence of muscular contractions.

This mobility persists as long as the periosteal sheath is not ossified and preserves a certain degree of flexibility. For this reason its duration is very variable. In some cases, when there is only a little suppuration, limited to one point, and medullization or rarefaction of the rest of the surface of the bone, the mobility is scarcely appreciable, and very transient. But when the end of the diaphysis is bathed in pus, and necrosis extends for a considerable distance, the abundance of the suppuration retards the plastic process, and the periosteal sheath remains a long time flexible and movable. The separated diaphysis may then be dragged in one direction by muscular contraction, and the necrosed extremity, which presses against the periosteal sheath, finally perforates it, and may even protrude under the skin. These displacements vary for each bone. I give here some illustrations:—

Here, first, is a separation of the upper end of the diaphysis of the tibia (Fig. 1432). The epiphysis has preserved its relation to the femur; the knee-joint is intact; but the diaphysis is displaced upon the epiphysis, and instead of being in the axis of the femur, it is inclined inwards. At first sight, it might be called a *genu-varum*; but, as I have just said, the knee is intact. In this case the necrosis lasted about two months, and some pieces of necrosed spongy tissue were eliminated. The limb may be partly brought back to its normal position and may become consolidated.

Among the cases which I have seen, I will mention the following, which involves both lower limbs, and which presents a forward deviation of the diaphysis of the femur, and a backward deviation of that of the tibia (Fig. 1433). Above the patella on the left side a second prominence is seen, as marked as that of the patella itself. This form is characteristic, and constitutes what I have designated under the name of double-knee. The epiphysis has been drawn backwards by the muscles which flex the leg upon the thigh, while the periosteal sheath has been still pliable; for, from this there has resulted an anterior projection, formed by the lower extremity of the diaphysis. Here it is the epiphysis which is displaced upon the diaphysis. In the tibia, the upper epiphysis has not moved at all, held back as it has been by the ligaments and the capsule of the joint, but the diaphysis has been

Fig. 1433.

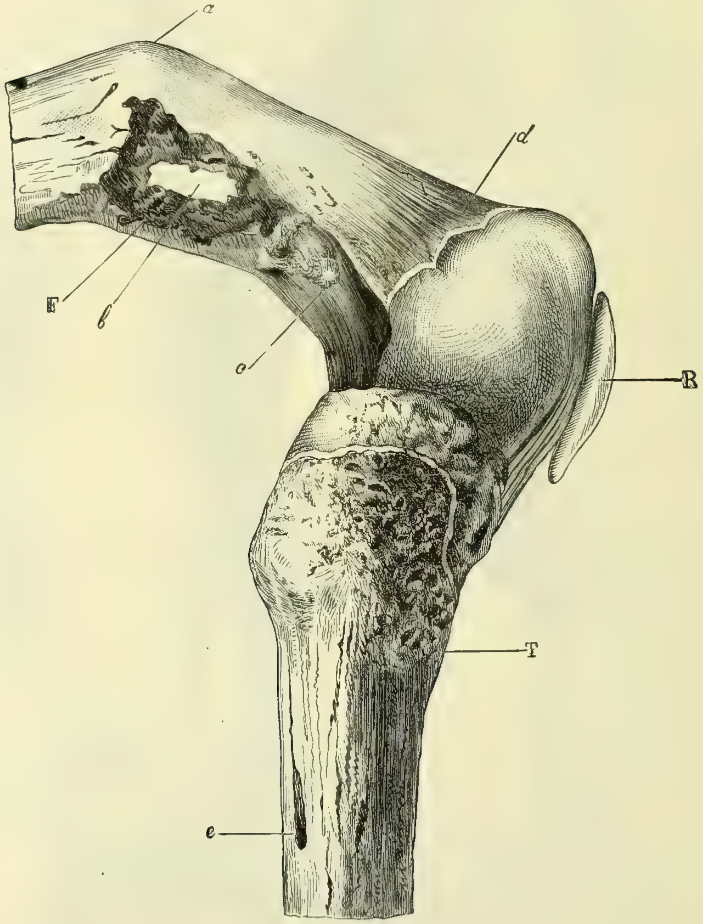


Double diaphyseal separation in the same patient, in consequence of juxta-epiphyseal osteitis: lower epiphysis of the left femur; upper epiphysis of the right tibia.

carried backwards. This deviation commenced while the patient still kept his bed, and it only became more pronounced when he began to walk.

I give here two drawings which will enable us to interpret the preceding cut (Fig. 1433), which represents a patient who was under my care in 1868, and who recovered completely. Some time afterwards, in 1869, being in Berlin, I saw in Wilms's collection two anatomical specimens, of which he was kind enough to permit me to make a sketch, and which illustrate exactly the same lesion. They were specimens coming from patients whose thighs he had amputated. The first (Fig. 1434) shows a curvature of the femur in the lower juxta-epiphyseal region. The patient had had a juxta-epiphyseal osteitis ending in necrosis. The sequestrum had protruded gradually through the opening B, and had been extracted. Inflammation propagated to the knee-joint had necessitated amputation through the thigh. In this specimen,

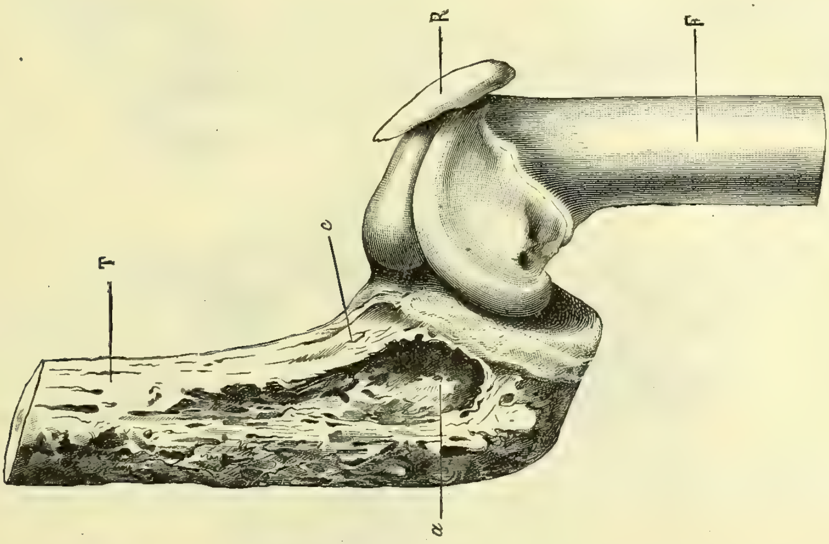
Fig. 1434.



F, femur; T, tibia; R, patella; *a*, angle formed by the meeting of the portion of the bone *a d*, developed since the beginning of the osteitis, with the old diaphysis. The connecting cartilage has become more and more distant from the diaphysis as it has furnished new layers of bone. This new portion of bone became bent upon the old portion while it was still but slightly rigid, being drawn backward by the flexor muscles. *b*, perforation through which a sequestrum has escaped.

it is seen that all the portion of the diaphysis formed since the osteitis, and comprised between the end of the diaphysis indicated by the prominence *a* and the connecting cartilage *d*, had from the beginning been drawn backward by muscular contraction. The result of this was a change of direction in the new portion, and the prominence which no doubt gave the limb the appearance of double-knee. Fig. 1435 shows a bending forward of the diaphysis of the tibia upon its upper epiphysis. There is a re-entrant angle in front and a projection behind. This is the same lesion as in the preceding figure.

Fig. 1435.



F, femur; R, patella; T, tibia. The tibia presents a flexion forwards of the diaphysis upon the epiphysis, which is itself slightly luxated behind the femur. A, juxta-epiphyseal sequestral cavity; B, epiphysis; C, diaphysis; D, angle pointing backwards, indicating the displacement of the diaphysis upon the epiphysis.

When inflammation attacks one bone of a limb-segment with parallel bones, like the leg or forearm, various deformities result, which are explicable either by the arrest of development in one of the bones, or by its excessive development. In the forearm, for example, when the radius is arrested in its development by an inflammation which destroys the lower connecting cartilage, the ulna, continuing to grow and being held back by its attachment at both ends to the radius, is forced to curve or to twist. The two epiphyses are almost fixed, since they are united to the radius which does not grow any more; and the diaphysis, which continues to elongate by ossification of the layers furnished by the connecting cartilages, necessarily takes a sinuous shape. I have shown experimentally[1] these different effects of arrest of growth in one of the bones of the leg or forearm, and I have, by partial excision of the connecting cartilages, reproduced all the deviations which are seen in man in consequence of the forms of osteitis which cause destruction of the connecting cartilages in childhood. In this way the knees may be made to deviate inward or outward, as well as the front and back feet.[2] These experiments led me further to practise excision of the connecting cartilages with a surgical object; that is to say, to correct deformities due to inequality of growth in parallel bones.[1] On the other hand, I have indicated the means of increasing in man the normal growth of bones, by permanent irritation of the diaphysis during the period of growth of the skeleton. Antiseptic methods will make it possible in future to have recourse without danger to these operations for the correction of deformities, which were formerly dangerous on account of the intra-medullary suppuration which they might produce when more than the superficial layers of the bone were implicated.

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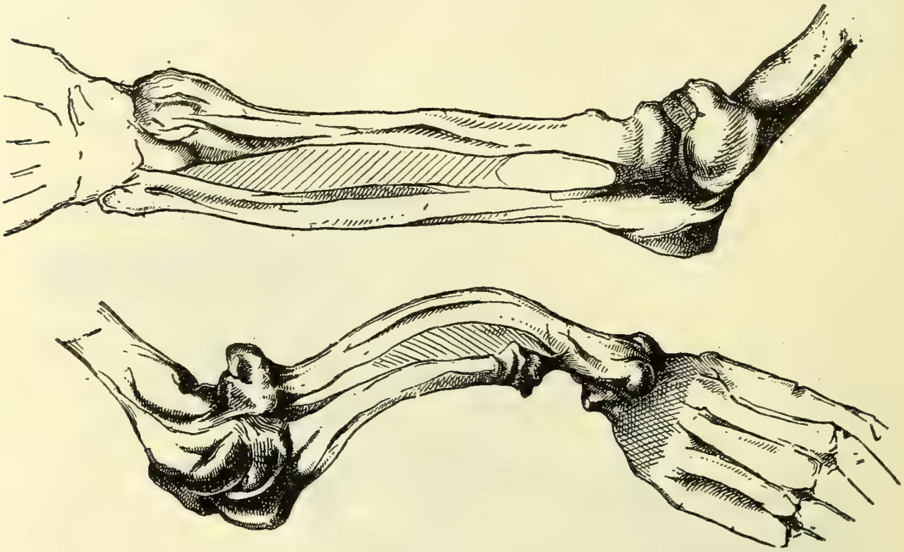
[1] Traité Expérimental et Clinique de la Régénération des Os.

[2] De l'Accroissement Normal et Pathologique des Os. 1872.

Fig. 1436.



Arrest of development of ulna as the result of juxta-epiphyseal osteitis. The radius having continued to grow is curved upon itself. (After Poncet.)

I have already spoken of the relation of osteitis to the seat of election for growth in the large bones of the limbs. I ought, before going further, to speak of this more fully, and to show that it is applicable to all the bones, whatever may be their shape. In all the flat bones, it is the juxta-epiphyseal regions, that is to say, the edges supplied with epiphyses, that are most exposed to osteitis. The pelvis and the scapula frequently present a demonstration of this law. Osteitis of the pelvis, which is so common during the period of growth of the skeleton, is seen especially at the time of puberty and at the end of the period of growth, as Gouilloud[2] has shown by numerous examples. In the calcaneum, the posterior extremity of the diaphysis, that which is connected with the epiphysis, is also the most common seat of acute osteitis during the period of growth. The anterior extremities of the ribs, near the cartilages, are subject to the same law.

If osteitis of the long bones sometimes produces displacements of the diaphysis by the mechanism indicated above, it likewise gives rise to fractures produced by muscular effort, or in consequence of slight traumatism, in the portion of bone which has lost its firmness under the influence of inflammation. These fractures are usually seen during convalescence from osteitis, when the patients, having passed beyond the acute and febrile period, begin to walk again and to use the limb.

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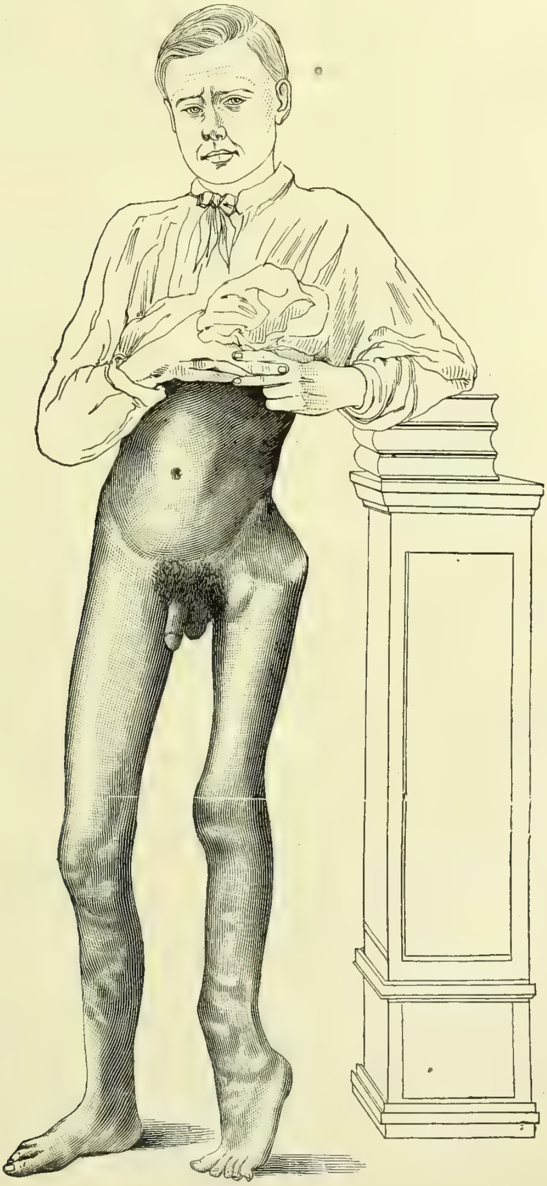
[1] Revue Mensuelle de Médecine et de Chirurgie. 1877.

[2] Des ostéites du bassin. Thèse de Lyon, 1883.

Fractures following osteitis are seen especially in the femur. The weight of the body and traumatisms act upon this bone in a manner well calculated to interrupt the continuity of the diaphysis when inflammation has altered its consistence. In the patient represented by Fig. 1437, a sub-trochanteric

Fig. 1437.



Double spontaneous fracture of bones affected with osteitis. *A*, fracture of the femur below the trochanter; *B*, fracture of the tibia in the lower third.

fracture of the femur, and a fracture of the lower third of the tibia, took place. The former was followed by inward displacement of the lower fragment, the latter by displacement of the lower fragment backward. I have also seen a case of spontaneous fracture following osteitis in the humerus, another in the first phalanx of the thumb, etc.

These fractures occur in two conditions, which make a great difference in the prognosis. Either they take place in a bone simply rarefied and no longer suppurating, or they occur at a centre of suppuration or in a necrosed portion. In the latter case the rupture may occur at the edge of the sequestrum; then it is only a sudden and speedy separation of the necrosed part, or else it involves only the portion of bone which is still living, the sequestrum being already isolated from it. The coincidence of a centre of suppuration, with or without necrosis, aggravates the prognosis. I lost some time ago, from pyæmia, two patients affected with old osteitis, who had broken the femur under these circumstances.

Apart from this risk, these fractures may be very hard to reduce, if time has been allowed for displacement to occur. The resistance of the chronically inflamed tissues prevents exact coaptation, and favors the production of deformity.

Necrosis of Bones.

Necrosis is not a disease, it is the termination or sequel of a disease. It is, as its name indicates, the death of the bone. A necrosed bone becomes a foreign body which the processes of elimination constantly tend to isolate from the living part. The isolated portion is called a *sequestrum*, but the word sequestrum is not synonymous with necrosis. The word sequestrum means a separated part. Thus, among the pieces of bone found to be movable in a patch of osteo-myelitis, some are wholly deprived of life and constitute the *sequestra of necrosis*, while others are still traversed by vessels and united with the neighboring tissues by vascular granulations; these are the *sequestra of osteitis* or of *caries*, that is to say, parts still living, isolated from the rest of the bone by peripheral medullization.

Among the sequestra of necrosis two varieties must be distinguished: primary sequestra, and consecutive or secondary sequestra. The first are the result of rapid death of a healthy bone, deprived of its vessels by any cause. The bone is dead without having been diseased, or at least without having had time to be altered by disease. It has, then, the structure, the consistence, and the hardness of healthy bone. The secondary or consecutive sequestra result from the death of a portion of bone already modified in structure by disease. They present the anatomical characteristics of the osteitis which has preceded and led to their death. They are usually rarefied, sometimes eburnated.

Nothing is more variable than the shape of sequestra. They correspond with the vascular territories, that is to say, with the distribution of the nutrient vessels of the bones. Being the immediate result of obliteration of these vessels, they represent the extent and shape of the obliterated vascular territory.

Bone-tissue is the more predisposed to necrosis the more it is compact, that is to say, the fewer vessels it contains, and the greater difficulty there is in establishing the collateral circulation. The vessels contained in the canals of Havers cannot undergo the processes of acute inflammation without being exposed to obliteration, and, as others cannot be established alongside of them, their obliteration is followed by death of the part which they nourish. In the spongy tissue the re-establishment of the circulation is easier, on account of the large size of the medullary spaces and the relatively free communication between them. Young bone-tissue is, other things being equal, less liable to necrosis than old bone-tissue. It is always the same question of vascularity. It is sometimes said that necrosis is more common in children that in adults. This is true, if regard be had only to the number of cases of necrosis; it is untrue, if it means that the bone of a child mortifies more easily than that of an adult. Under the same anatomical conditions, the bone of the adult is much more liable to necrosis than that of the child; and if account be taken of the large number of bone-affections in children, and of the relatively small number of cases of spontaneous osteitis in adults, the truth will be discovered by reversing the above proposition. Vascular communication between the different parts making up the bone takes place so easily in childhood, that necrosis is possible only after extensive vascular destruction.

It is often said that denudation of bone causes necrosis. I have shown by numerous and varied experiments that this is not so. I have, in young subjects, removed the whole of the periosteum of the diaphysis, or have completely emptied the medullary canal, without producing necrosis.[1] I have even, in certain experiments, removed simultaneously the periosteum and the medulla without causing death of the bone. But, in order that life shall be preserved in these cases, it is necessary to obtain immediate union of the wound, that is to say, immediate adhesion of the tissues peripheral to the denuded bone, and to prevent the formation of pus in the medulla. In young bone-tissue, medullization of the canals of Havers takes place so rapidly, and anastomoses of these canals are then so readily established, that the circulation is restored.

What brings about necrosis is not the denudation of the bone, it is the inflammation which follows this denudation. At a seat of fracture protected from the air, completely movable splinters become engrafted and continue to live.

In operations upon man and in experiments upon animals, it is possible nowadays, by means of vigorous antisepsis, to preserve the vitality of bone-tissue after the severest traumatisms. Formerly, necrosis almost always resulted under these circumstances; the wounds became inflamed, and, the vessels of the bone being obliterated, its death was the inevitable consequence. The bones, as I long since proved,[2] may become engrafted like other living tissues; they are engrafted by the periosteum and by the medulla, especially by their periosteum. Completely detached scales may continue to live, not only in a protected fracture, which is the rule, but also in open fractures, to the seat of which air may have entered. It is a question of asepsis.

But if denudation of a bone does not of itself cause necrosis, if the destruction of its periosteum or medulla is not followed by death of the bone-substance, it does not follow that denudations of bone are not serious complications, either in spontaneous or in traumatic osteitis. In amputations, the end of the bone, more or less deprived of its periosteum, is liable to annular necrosis, and extensive periostitis with separation of the membrane causes more or less extensive necrosis, even without concomitant osteo-myelitis.

After necrosis by denudation and necrosis from acute inflammation, I ought to mention necrosis from progressive anæmia of the bone, such as is met with in certain inflammatory processes which produce at different points progressive eburnation. To the rarefaction of the first period of osteitis succeeds a condensation, or rather an eburnation of the bone-tissue, which may go on to obliteration of most of the canals of Havers. From this come the eburnated sequestra which are found in the midst of purulent or fungating foci, and which many surgeons have considered, since the researches of Nélaton, as tuberculous products. I cannot admit this interpretation without reserve, so far that I do not consider these eburnated masses to have been originally the seat of the tuberculous neoplasia. I do not regard them as tuberculous, but as para-tuberculous products, if I may so express myself, that is to say, products formed alongside of tuberculous deposits. They are one of the multiple forms of chronic osteitis which accompany tubercle of the bones, but not a phase of tuberculosis itself.

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[1] Traité Expérimental et Clinique de la Régénération des Os, t. i.

[2] Des greffes osseuses (Journal de la Physiologie de Brown-Séquard, 1869).

Figs. 1438 and 1439 show a specimen of these eburnated masses, which take a long time to form, and which are but slowly separated from the organism. I cannot admit that these masses, which by their eburnated nature are very refractory to tuberculosis, can be its product. Figure 1438 shows the articular surface of the condyles of a femur, the protruding part of which is deprived of cartilage, smooth, and eburnated. The internal condyle shows a sequestrum which is beginning to be separated from the surrounding parts; on the external condyle, separation has not yet begun appreciably. In the section of the internal condyle (Fig. 1439) it is seen that the eburnated part corresponds to a mass of the same structure, which occupies a large part of the thickness of the bone.

Fig. 1438.

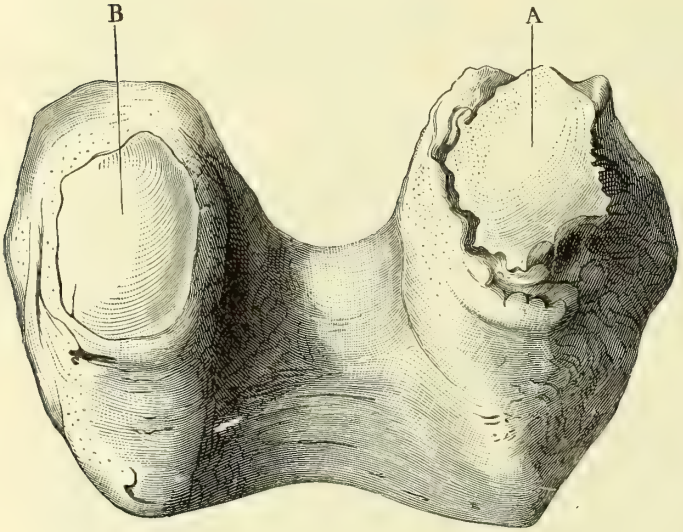
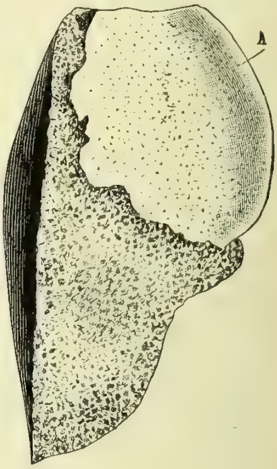


Fig. 1439.



Condyles of the femur, removed in a resection of the knee, presenting at their lower part hard masses, eburnated by condensing osteitis. The mass *B* is continuous with the neighboring portions of bone. The mass *A* is already to a great extent isolated from the healthy tissues. In the section, Fig. 1439, it is seen to be necrosed, except perhaps at its upper part, where in the fresh specimen an irregularly outlined, slightly rosy point could be distinguished.

Doubtless tuberculous products may be found around these eburnated masses; but they have never been found in their tissue. The histology of these eburnated sequestra has been well studied by Ranvier, who found in their structure the remains of the old bone which had escaped the rarefying osteitis, in the midst of bony deposits of new formation. The arrangement of the lamellæ differs in the two tissues.

The sequestra of osteitis, which are, I repeat, only living portions of bone isolated from the neighboring parts by peripheral medullization, may present all the anatomical characteristics which are met with in the different forms of osteitis. These sequestra often present necrosed parts, and then constitute *mixed sequestra*, which have in part the character of sequestra of necrosis, and in part the character of sequestra of osteitis. These sequestra behave quite differently in the midst of living tissues. The sequestra of original necrosis, when they are formed from the compact tissue of the diaphysis, may remain indefinitely inclosed in a suppurating cavity. Pus does not alter them, or at least does not dissolve them. I have removed from the middle of the tibia a number of small sequestra which had remained shut up for more than half a century. I have removed almost the whole of the diaphysis of a femur which had been necrosed for seven years, and which had undergone no appreciable alteration. But, if pus does not dissolve them, vascular granulations, arising from the medulla, may after a while alter and absorb them. Ivory pegs driven into the bones for the cure of pseudarthrosis, are eroded by the granulations which surround them. Small portions of dead bone introduced into the midst of living tissues, either in the medullary canal or in the cellular tissue, disappear at the end of a certain time. They disappear, above all, when the wound does not suppurate, or suppurates but slightly. As I have just said, pus does not dissolve them, but the granulations absorb them. Vascular tufts enter the canals of Havers, penetrate them, enlarge them, and finally absorb them by lacunar erosion, by a process which has some analogy with that of osteitis, but which differs from it inasmuch as the granulations come from tissues foreign to the bone.

While these small sequestra of necrosis may at length disappear by means of absorption effected by the peripheral granulations, the sequestra of osteitis disappear by an altogether different mechanism. They disappear by medullization, that is to say, by a continuation of the process of rarefying osteitis. It is their own medullary elements that absorb the bony substance all around them.

One of the most interesting phenomena to be studied in the history of necrosis, is the mode of repair of necrosed bones. For a number of centuries there had been noticed, after necrosis, examples of the regeneration of bone (Scultetus, Ruysch, etc.), and the explanation which was given of these cases was always based upon the physiological ideas of the times. After the celebrated experiments of Duhamel, the regeneration of bone was sought to be explained by the periosteum. The researches of Troja were interpreted in this way. Then, following Bichat, Scarpa, and Léveillé, the periosteum was dispossessed of all regenerative power, and regeneration was sought to be explained by hypertrophy of the remaining bone. I have elsewhere[1] discussed at length all these questions, and I have shown how far from accurate are the theories based upon cases of necrosis observed in man. It is impossible thus to analyze accurately the phenomena of regeneration; so many influences may contribute to it, that arguments can be found in favor of all theories. Experimental analysis is indispensable in order to unravel the problem, and further, it is necessary to have recourse to processes of experimentation more exact and more demonstrative than the production of artificial necrosis.

The periosteum is unquestionably the most important organ in the regeneration of bone. It is the only organ which can bring about regeneration of a considerable portion of bone, or of an entire bone. The medulla may indeed ossify—it is often transformed into bone-tissue in osteitis; but it does not follow from this that it can of itself repair an entire bone or a diaphysis.

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[1] Traité Expérimental et Clinique de la Régénération des Os, t. i. et ii.

While it ossifies when it remains in contact with the bone, it usually remains soft and pliable when the peripheral cylinder of bone has been destroyed by necrosis or artificially removed. The periosteum, on the contrary, isolated from the bone, reproduces bony masses which, in conditions which I have determined experimentally, recall the form and dimensions of the bone removed. Its ossifying properties are dependent upon the conservation of its osteogenic layer, that is to say, of the layer of embryonic cells which exists on its deep surface. This layer is very easy to demonstrate in the bones of young subjects, especially in children; but it disappears in adults and old persons, and becomes apparent in these last only when the periosteum has been previously irritated. Artificial irritation of the periosteum restores to this membrane, in old animals, the properties of youth. For this reason bony new formations are not limited to childhood and adolescence; they may be produced at a later period when the periosteum has undergone a certain degree of irritation, which renews in its cells the properties which they had lost.

In necrosis of the whole thickness of a bone, regeneration is dependent upon this osteogenic layer. If it has been destroyed by the violence of the inflammation, as happens in diffuse periostitis which in a few days transforms the periosteal sheath into a purulent sac, in which the whole of the diaphysis is found necrosed, regeneration may fail utterly in spite of the youth of the subject. I have seen, among other cases, a necrosis of the ulna, following a very acute pan-diaphysitis, which was not followed by the formation of the smallest osteophyte, although the child was only four years old.

Acute inflammations which begin in the periosteum, often destroy the whole of the osteogenic layer. Inflammations originating in the medulla, which attack the periosteum only secondarily, are of less gravity in this respect. Intense and destructive in the medulla, these inflammations lessen in intensity as they traverse the bone-substance, and reach the periosteum so much enfeebled as to provoke only plastic processes. Hence those enormous subperiosteal bony layers which are provoked by irritating the medulla in animals, and of which clinical observation furnishes frequent examples in children. On this account the seat and point of departure of inflammation have a great influence upon the regeneration of bone. If indirect irritation of the periosteum is usually fruitful, its direct irritation runs a risk of being sterile when it is too intense.

Nothing is more simple, apparently, than the theories of regeneration given by different authors who have wished to apply to surgery the ideas of Duhamel and of Troja. By the action of the periosteum or of the medulla, which, according to these theories, is only an internal periosteum, all is explained. It is sometimes one, sometimes the other of these tissues which does the work. In reality, the question is more complicated; and when we consider the majority of the sequestra removed by sequestrotomy, we can understand how Brun, Léveillé, Scarpa, etc., maintained that the new bone was only the result of hypertrophy of the part remaining. Indeed, in the majority of the sequestra removed, it is seen that they are not made up of the whole thickness of the cylinder of the diaphysis. There generally remains a portion which has continued to live, and which may have played an important part in the reconstruction of the bone. Total necrosis is rare. There generally remain, even in cases in which a superficial examination would lead to the belief that the whole bone had become necrosed, some living portions adherent to the periosteum, which will play an important part in the osseous new formation.

When a sequestrum, representing the greater part of the diaphysis of a long bone, is examined attentively, it may be determined, from its shape and appearance, by what elements the new bone has been reconstituted. If the sequestrum is smooth and single, without erosions or losses of substance, the new bone can only have been reconstructed at this point by the periosteum. If its continuity is interrupted in part of the circumference, if it is reduced in some places to a portion of the normal thickness of the bone, reconstruction has taken place both by the periosteum, which corresponds to its smooth surface, and by portions of the old bone, which correspond to the eroded or absent parts. I am speaking here only of the sequestra of frank necrosis, resulting from acute osteitis, that is to say, of parts of bone dying suddenly, without having been previously affected, and therefore having the character of healthy bone-tissue.

Now, in these cases, the sequestrum represents exactly the bony deficit; the erosions and the deep furrows which cross its surface have not been made at its expense; these inequalities indicate that small portions of the superficial layer of the bone have remained adherent to the periosteum.

It is in the large bones of the limbs that the most beautiful examples of regeneration of bone have been observed. Yet all the bones may be reproduced more or less. The short bones themselves, and the epiphyses, are susceptible of a certain degree of reproduction, which is proportioned to the extent of their periosteal sheath. The portions of bone in great part covered with cartilage, like the head and neck of the femur, the astragalus, etc., are hardly susceptible of reproduction. The periosteum can reproduce only that which it encases, and that of which it furnishes the normal materials of growth. Examples of reproduction of the diaphysis of the large bones of the limbs have been known for a long time, and there is not a pathological museum which does not possess some specimens of the kind. I give here (Fig. 1440) a drawing of a specimen in the Musée Dupuytren, which relates to a necrosis of the lower three-fourths of the diaphysis of the humerus. The necrosed diaphysis is surrounded by a peripheral ossification which can only be attributed to the periosteum.

The flat bones are also susceptible of reproduction by the same mechanism, and the necrosed lower maxilla is sometimes seen included between two ossified layers of new formation, one inside the mouth, the other outside. The same is true of the scapula; the old bone is included between two plates formed by periosteal ossification.

Regeneration of the short bones has been rarely observed after necrosis. I reproduce here (Fig. 1442) an illustration of reproduction of a bony shell around the necrosed calcaneum.

Surgeons have always been divided on the question of the proper time for interference in necrosis; not in regard to the removal of movable sequestra, for all are agreed on this point, but in regard to the removal of necrosed parts still adherent to the periosteum to a certain extent, or still connected with a healthy part of the bone. There will be but little serious difficulty if regard be had to the mode of regeneration of bones after necrosis, and to the nature of the work by which the repair of sequestra takes place.

When the inflammatory phenomena have abated, when the pus is in small quantity and flows freely, when septic accidents are no longer to be feared, the separation of the sequestra ought to be left to nature, or at least not precipitated. There would, in this case, be a risk of deranging the plastic process which is going on, and of reviving the inflammation which is just dying out. But it should be well understood that one should thus wait only when it can be done without danger and without too much inconvenience to the patient.

Whenever the presence of the necrosed portion keeps up abundant suppuration which may exhaust or poison the patient, this necrosed portion should be removed.

Fig. 1440.

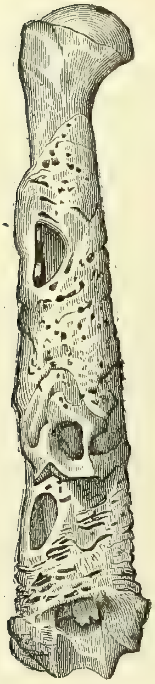

Fig. 1441.

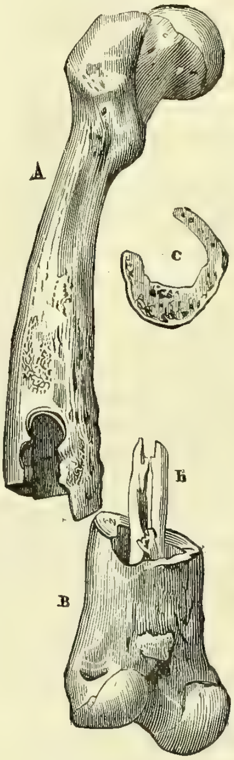

Fig. 1442.

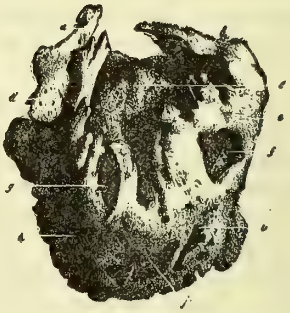

Fig. 1440. Case of necrosis from the Musée Dupuytren. Almost the whole of the diaphysis of the humerus has perished. The new bone is completely solidified. Cloacæ are seen, openings which expose to view a large, movable, invaginated sequestrum, free in the cavity of the new bone. (Musée Dupuytren, No. 346.)

Fig. 1441. Invaginated necrosis of the lower part of the femur. The bone is represented out in three pieces. *A*, the upper fragment; at its lower part is seen a large hole made with the trephine. *B*, is the lower fragment; the sequestrum is seen to be invaginated at the end toward the condyles. *C*, is a section of the bone which shows the areolar structure of the ossification.

Fig. 1442. Necrosis of the calcaneum; ossification of the periosteal sheath around the necrosed bone. (After Gerdy.)

In necrosis of the maxillæ, for example, the flow of pus into the mouth is a constant source of poisoning; in necrosis of the whole diaphysis of the tibia, suppuration over so extensive a region exhausts the organism. Then the cause which keeps up the suppuration should be removed, whatever effect the operation may have upon the properties of the periosteum. Regeneration of the bone is of secondary importance here; to save life is the first consideration.

To conclude, necrosed parts ought to be removed if they are doing harm, and their separation should be waited for if they are not causing serious trouble. The longer one waits from the time when fever and constitutional symptoms have come to an end, the better the chance of finding the periosteum in possession of all its osteogenic properties. As soon as the fever declines, the destructive processes are arrested, and the plastic processes become more active. The periosteum thickens more and more, increases in consistence, and becomes like cartilage. The dead bone keeps up, it is true, a certain degree of irritation in the affected region; but this irritation is productive of ossification; it excites and maintains the proliferation of ossifiable cells. The periosteum is now in favorable osteogenic condition, and may be easily, and without danger, separated from the bone at the points where it still adheres.

As soon as the periosteum is found in this condition, the necrosed portion may be removed, although it may not have precise limits. The duration of suppuration is thereby shortened, incarceration of the sequestrum in an ossified cavity is avoided, and finally the patient is cured more quickly without compromising the regeneration of the bone. Lister's dressing gives another reason for hastening these operations; by preventing inflammation of the wound, it prevents the renewal of destructive processes.

The relations of the bone furnish also a guide for hastening or delaying an operation. If the bone concerned is the sole support of a limb, like the humerus or the femur, it is well to leave the periosteal sheath to become hyperplastic, and even to give it time to harden. A tissue already of the consistence of cartilage will soon be invaded by ossification, and may, with the help of a supporting apparatus, maintain exactly the shape of the limb.[1] I insist the more on this preparation of the periosteum, because I have seen regeneration fail to take place in children in whom the diaphysis of the tibia had been removed for osteo-myelitis with small intra-medullary sequestra, without waiting for sub-periosteal hyperplasia.

The extraction of sequestra does not constitute a resection; the operation is the same as for the removal of a foreign body. It has been given the name of *sequestrotomy* or *necrotomy.*

Systematized and practised with temerity by David, at the end of the last century, this operation is at the present day one of the commonest in surgical practice. It differs much according as one has to do with a superficial sequestrum, or with a sequestrum incarcerated in thick layers of newly formed bone.

Ablation of a movable sequestrum, superficially situated and covered by only more or less indurated fibrous layers, necessitates only an incision of the soft parts; but extraction of an incarcerated sequestrum often necessitates a preliminary operation, which in certain regions is laborious and difficult. It is sometimes necessary to cut with the gouge, chisel, or trephine, large openings in the bone, which is considerably thickened by the deposit of subperiosteal layers of new formation. A small sequestrum, incarcerated in a region difficult of access, often requires a long and laborious operation, which risks breaking the bone if the needful precautions are not taken to control the position of the limb.

These operations, practised upon bones hypertrophied by inflammation, have always been less grave than analogous operations upon healthy bones. The eburnation of the peripheral bone, and the obliteration of the medullary canal, altogether change the character of these osseous wounds. And they are still less to be dreaded nowadays with antiseptic dressings.

If the extraction of movable sequestra is a totally different operation from resection, it is not the same as regards removal of necrosed parts which are not yet separated from the healthy bone. If, for example, we cut away a juxta-epiphyseal or articular extremity, which is bathed in pus but still attached to the rest of the bone, from which it cannot be distinguished by precise limits, then we do a true resection involving the healthy bone. These resections for adherent necrosed bone are made necessary by the abundance of the suppuration, and by the infective complications which stagnation of pus may cause. They may be insufficient if the section of the bone comes just to the level of the apparent limits of the necrosis, it being possible that the necrotic process may extend secondarily to the inflamed parts. It is necessary, then, if we do not wish to run the risk of seeing a greater or less extent of the end of the bone die, to saw where the bone is perfectly healthy; and even in this latter case we may have secondarily an annular necrosis, if the periosteum has been stripped up too far, and if the wound becomes consecutively the seat of a suppurative inflammation.

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[1] Scultetus (Armamentarium Chirurgicum), as early as the seventeenth century, removed the dead bone in a number of cases by incising the thickened periosteum, which he called cartilage. Cartier (Précis d'Observations de Clinique faites à l'Hôtel-Dieu de Lyon, 1802), removed the whole diaphysis of the tibia while the periosteal sheath was soft and flexible. The limb was placed in a fracture apparatus, and the bone re-formed, preserving almost its original shape.

The rule to leave to Nature the care of limiting and separating necrosed parts, has its drawbacks in certain regions. It has everywhere the disadvantage of requiring much time, and of prolonging the period of suppuration. For a long time surgeons have asked themselves if the separation of sequestra ought not to be hastened by scraping, by shelling off, and by perforating, the bone. Belloste, in order to quicken the separation of sequestra of the cranium, recommended perforating the dead part with a number of holes, penetrating to the living part and making it possible for granulations to emerge through the sequestrum and contribute to its absorption. Before the time of antiseptic dressings this method had no advantages, and some comparative experiments which I formerly made demonstrated that the separation of sequestra was not hastened, and that there was danger of increasing the necrosis in depth by the simple fact that new wounds were made, which were prone to inflame and to become infected.[1]

With the antiseptic method we may attack these superficial necroses more boldly, removing the necrosed part promptly with a chisel or raspatory penetrating to the healthy bone. Poncet has thus accelerated cicatrization of denudations of the cranium.[2] In many other regions we should adopt the same plan, lest we should see bone-wounds slowly suppurating for months, when scraping or superficial removal might have cured them in a few days.

Sequestrotomy sometimes reduces itself to simple extraction of the sequestrum. The dead bone removed, all returns to order; the cavity rapidly fills with granulations which soon form a fibrous mass and finally ossify, especially if the periosteum can take part in the process. It often happens, however, that these cavities are obliterated by fibrous tissue which persists indefinitely; but this lack of ossification is especially seen in chronic lesions involving the spongy tissue. In frank necrosis, and in young subjects, the plasticity of the walls of the sequestrum-cavity generally bring about bony consolidation.

In osteo-myelitis which passes on to the chronic state, and gives rise to the complex anatomical forms which I have described, we must not be content with removing the small movable sequestra which are discovered, but should scoop out the whole of the affected region, and remove the altered medulla, whether gelatinous or fungous, which is found there.

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[1] Traité de la Régénération des Os, t. ii. chap. i.

[2] Deporte, De la nécrose superficielle (Thèse). Lyon, 1882.

SCROFULO-TUBERCULOUS AND OTHER STRUCTURAL DISEASES OF BONES.

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Scrofulo-tuberculous Affections of Bones.

Under this title I shall consider together scrofula and tubercle of the bones, because their pathological histology tends more and more to become similar, and because it is impossible to give a sketch of them separately without falling into frequent repetitions. Scrofula is only a mitigated manifestation, initial and usually external, of tuberculosis, and it leads to the latter more or less rapidly. The forms of chronic osteitis which appear under the influence of these two phases of evolution of the same diathesis, or general tendency of the organism, have not well-defined characteristics which differentiate them exactly. If the general appearance of the patient reveals the traits attributed to scrofula, or to tuberculosis, the osteitis is spoken of as scrofulous or tuberculous, although this distinction may not be fully warranted either by the symptoms or by the pathological anatomy of the affection. Even the microscope does not assist in this separation, for it reveals, in most sections of these inflamed bones, both embryonic tubercles (*scrofulomata* of Grancher) and fully developed tubercles (*gray granulations* of Laënnec).

If the embryonic or adult tubercle, if the bacillus or the zoöglear masses are what characterize tuberculosis in process of evolution (scrofula) as well as that which has already undergone evolution (tuberculosis), my description ought to include not only the subject of *tuberculous affections of the bones*—a chapter created by Nélaton—but also *caries*, with its varieties, and *spina-ventosa*, lesions in which these neoplastic or parasific elements are found. I ought also to mention *ossifluent abscesses*,[1] sessile or by congestion, as well as *white swellings* (fungous osteo-arthritis), which are extremely common consequences of the localization in the bones of tuberculosis in its different stages of evolution.

Historical and General Considerations.—The history of scrofulo-tuberculous osteopathies is not very old. Its first page was written by Nélaton, who first described the morbid entity, *tuberculosis of the bones*, separating it from the group *caries.* After numerous vicissitudes, the idea of the French surgeon was accepted by the whole world, so much so that at the present day tuberculosis only is recognized in chronic osteitis, and caries itself is regarded by many as a tuberculous affection of the bones. Not merely a branch of the group, but the whole morbid group of caries belongs to tuberculosis.

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[1] [Ossifluent abscesses are such as originate or "flow" from bone-disease; sessile abscesses are those which are found in contact with the diseased bone, and abscesses by congestion those which occur at a greater or less distance.]

In his historical sketch, Professor A. Nélaton[1] traces back to the earliest times the knowledge of tuberculosis of the bones. He says that Hippocrates and Galen mention tubercle of the bones in the most precise way. Marcus Aurelius Severinus and Mercurialis also speak of it at great length. In 1735, Traugott Gerber treated likewise of vertebral tuberculosis as of a thing well known, and attributed to it the formation of spinal curvatures. The collection of dissertations of Platner contains, finally, a thesis of Frederic Haacke, "the title of which alone, *De iis qui a tuberculis gibbosi fiunt*, suffices to show what were the ruling ideas at that time in regard to this point of science."

The word tubercle is indeed frequently found in the works of the oldest authors; but this is all. This word had not at first the meaning which we have attached to it since the time of Laënnec and Bayle. Every morbid product of small size and of globular or nodular shape was called tubercle. There were scrofulous, syphilitic, and cancerous tubercles, etc. The word tubercle referred only to shape, while now it refers both to shape and to nature; that is to say, to the something which gives rise to general phthisis, and especially to the most common and best known type of this disease, pulmonary phthisis. If, then, the employment of the word is ancient, the idea of the thing is modern. It begins with the immortal works of those French physicians, Bayle and Laënnec, upon phthisis.

Delpech[2] appears to be the first who, with a true notion of tubercle, raised the question of tubercle of the bones. In 1830, Serres, of Montpellier, developed the teaching of his compatriot. In 1835, Nichet, of Lyons, discussing Pott's disease, like his predecessors, followed their example in considering it a tuberculous affection of the bones.[3] Pott's disease also furnished the subject of the researches made by Reid, of Erlangen,[4] Parise,[5] Tavignot,[6] and others. All these authors studied only Pott's disease, and endeavored to prove that this disease was not common caries, but a tuberculous affection.

"That which Bayle and Laënnec did for the lung, in explaining the natural history of the evolution of tuberculosis, remained yet to be done for bone-tissue; this is the point in the pathology of the bones, of which," says Nélaton, "I have endeavored to treat."[7] Nélaton distinguishes, in the bones, two forms of tuberculosis. Sometimes the tuberculous matter is found collected in one or several centres, hollowed out of the substance of the bone-tissue (*encysted tubercle*); sometimes it is infiltrated in the cells of the spongy tissue (*tuberculous infiltration*). Each of these forms has anatomical characteristics which make it possible to differentiate it at all stages of the disease. Thus, the nature and modalities of the affection are well described by Nélaton, whose doctrine regarded not the vertebræ only, but the whole of the osseous system. There has been cited, as having preceded him in this matter, a physician of the name of Suren, who, in 1834, issued a thesis[8] in which he described the miliary and conglomerate, as well as the infiltrated, forms of tubercle of the bones. It is beyond doubt that Nélaton had not the least knowledge of this obscure dissertation, otherwise he would have cited it—he who had taken such pains to discover those who had preceded him in the most remote ages. It is not less certain that, if tuberculosis of the bones had had no other advocate than Suren, we might still be ignorant of it.

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[1] Elemens de Pathologie Chirurgicale, t. ii.

[2] Traité des Maladies Réputées Chirurgicales, t. iii. 1816.

[3] Mémoire sur la nature et le traitement du mal vertébral de Pott. (Gazette Médicale.)

[4] Annales de la Chirurgie Française et Étrangère, 1843.

[5] Archives Générales de Médecine, 1843.

[6] L'Expérience, 1844.

[7] Thèse inaugurale, 1836.

[8] De ossium tuberculis. Berolini, 1834.

Since the monograph of Aug. Nélaton, many papers on tuberculous affections of the bones have been published by Denonvilliers, Lebert,[1] Robin,[2] Malespine, Virchow, Ordonez, Gonzales Echeverria, Chassaignac, Cornil and Ranvier, Gerdy, Volkmann, Lazarus, Bennett, Goetz, Macnamara, Gosselin,[3] Baumgarten, Abelin, Lannelongue, Kraske, Parrot, König, Köster, Sonnenburg, Heydenreich, Kiener, Poulet, Martin, Charles Nélaton, Albert, Ollier, and others. I cannot mention all the authors. Among these, agreement is far from being complete. Some deny or limit, others accept and extend, the teachings of Nélaton. The fluctuations of medical opinion relative to the nature of tuberculosis in general, have been felt at all times in the ideas of surgeons who occupy themselves with the pathology of the bones.

In 1850, Reinhardt opened the campaign against the unity of phthisis, by affirming, on the evidence of the microscope, that the tuberculous infiltration of Laënnec was only a catarrhal pneumonia, in which the lung was incapable of freeing itself from the products of inflammation. Then came Virchow, declaring with the authority of his name that the gray granulation was the sole and only criterion of tuberculous affections, and that the infiltrations called tuberculous, the caseous masses seen in the lungs of the phthisical, were only inflammatory products in scrofulous persons. There were, therefore, two varieties of phthisical persons, those whom gray granulation made truly tuberculous, and those whom caseation of the inflammatory products of a pneumonia rendered merely phthisical. Ranvier was the ardent propagator of these trans-Rhenal ideas in France. Dualism substituted itself in this manner for unicism; and consequently all caseous products infiltrated in the spongy tissue of the bones were considered as simple purulent collections in retrograde metamorphosis. Then nothing was spoken of but caseous osteitis; to admit tuberculous osteitis, the gray granulation was absolutely required.

The restoration of unicism has now restored to the doctrine of Nélaton all the ground lost, with more or less legitimate additions.

To M. Grancher is due in large part the honor of having dethroned German dualism, and of having brought about the triumph of the principle of unicism established by Laënnec. He can write with full justice: "I have contributed, for my part, to overturn that doctrine of dualism, by showing the different stages of evolution of a tuberculous granulation, from its embryonic period to its old age; and also the various transformations which it may undergo, according to its evolutionary tendency, toward the caseous, or towards the fibrous state."[4] According to M. Grancher, the granulation of Laënnec, the gray, semi-transparent granulation, is not an initial, but an adult product. "Other granulations, yellow and soft, are also adult products, in which the caseous state predominates, and the evolutionary tendency of which is toward fusion with other near granulations to form a giant tubercle. These, in their turn, unite, invade a lobe of the lung, or even an entire lung, and give rise to tuberculous pneumonia, then called caseous. The tubercle, then, exists before the gray or yellow granulation, and after it. Its definition ought not to be limited to the adult age, it deserves this name also in the earlier and later periods, that is to say, during the whole course of its evolution." M. Grancher has been able to follow the different phases of evolution of the tuberculous process, to see it pass from the rudimentary state to the state of complete development. At the beginning there is an ordinary cellular proliferation, common granulation-tissue, which would not have any signification if there were not in its neighborhood more advanced formations. These embryonic cells arrange themselves in a circle, and group themselves into microscopic nodules. This is what M. Grancher calls an embryonic tubercle, and M. Malassez an elementary tubercle.

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[1] Traité Pratique des Maladies Scrofuleuses et Tuberculeuses. Paris, 1849.

[2] Littré, Dictionnaire de Médecine, 15e édition. Paris, 1884.

[3] Clinique Chirurgicale de la Charité, 3e édition. Paris, 1884.

[4] Dict. Encyclop. des Sciences Médicales, Art. Scrofule.

This tubercle, or embryonic nodule, being met with in larger numbers in scrofulous affections, M. Grancher also calls it scrofuloma. Scrofuloma is characteristic of scrofula, and, engendering tubercle, explains how a scrofulous person may become tuberculous, and how the same patient may perhaps have at the same time strumous and tuberculous lesions. The following is the mode in which scrofuloma becomes tubercle, according to M. Grancher: In the centre of the group of cells there appears a homogeneous mass, opaque and yellow, in a new evolution, surrounded by clusters of epithelioid cells. This collar of epithelioid cells is itself surrounded by a zone of embryonic cells. What has happened? The original embryonic cells of the centre of the group have undergone transformations which have provoked their fusion. The fusion of these cells gives rise to the cell called a giant-cell, and announces caseous degeneration. So think MM. Charcot and Grancher. According to others, the so-called giant-cell is made by cutting across the small vessel, pre-existent or of new formation, around and at the expense of which the tuberculous follicle is developed (Cornil and Ranvier, Kierner, etc.). The union of a number of tuberculous follicles in a single mass constitutes the complete maturation of the tuberculous process, that is to say, the old gray granulation of Laënnec, the conglomerate tubercle of M. Charcot.

If such is the evolution of tubercle, the gray granulation, which suffices, when it is present, to fix the character of a lesion, can no longer be considered the univocal criterion of tuberculosis. Which is the metamorphosis of the tubercle-cell, which is the most constant? The study of this question has called forth numerous histological works. In 1868, Langhans, after having discovered the epithelioid cells and the giant-cells, believed that those cells alone were characteristic of tuberculosis. Schuppel adopted these ideas. Köster having found the giant-cell and epithelioid cells in fungosities of the joints, Friedlander in lupus, and at a later period Brissaud and Josias in scrofulous gummata and Lannelongue in the walls of independent cold abscesses as well as in those of ossifluent abscesses, there was no hesitation in declaring the characteristic suggested by Langhans and Schuppel to be true. But soon the same elements—tuberculous follicles and giant-cells—were met with in the gummata of syphilis, in the ulcers of lepra, in sarcoma, in granulations; and, to complete the confusion, tuberculous follicles and giant-cells were obtained at will by injecting animal matters, or any inert matter whatsoever, into the lungs, the bloodvessels, the cellular tissue, and the peritoneum of animals, or by simply placing in their abdomen elder-pith, fragments of glass, etc. The univocal criterion of tuberculosis was, then, still to be sought for.

It was at this time that M. Martin[1] was led by experimentation to distinguish *true tubercles* and *pseudo-tubercles.* The latter are only common inflammatory products provoked by the injection of irritating materials into the tissues, and, when they are inoculated upon new animals, they are not reproduced; whilst the tubercles resulting from the inoculation of true tuberculous matter, inoculated in their turn, are reproduced indefinitely from one animal to another, giving rise constantly to generalization of the tubercle. This is what is called inoculation and generalization in series, a method up to the present time uncontested, and the only one by which to distinguish true tubercle from pseudo-tubercle. Before M. Martin, M. Colin, of Alfort,[1] and M. Toussaint had already established the generalization in series of tuberculous inoculations. But it was undeniably M. Martin who first sought by this method of experimentation the means of surely distinguishing pseudo-tubercle from true tubercle. The capital fact upon which generalization in series rests is the *inoculability of tuberculosis.*

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[1] Archives de Physiologie, 1881.

The inoculability of tuberculosis in both its forms had been demonstrated as early as 1865 by M. Villemin,[2] who had also practised inoculations in series to refute the objection which was made to him, viz., "that tuberculous matter taken from a human corpse might well have no other action than that of a cadaveric substance."[3] In 1869, M. Chauveau rendered a number of animals tuberculous by making them swallow tuberculous matter obtained from the lungs of phthisical persons. Inoculability by the digestive passages was thus demonstrated. It is not necessary for me to dwell upon the importance of these researches of French experimenters, in regard to alimentation and hygiene.

What is the infecting agent in these inoculations? Is it a chemical substance, or is it a micro-organism, which is carried and which is propagated in inoculations and in generalizations in series, and which gives to tuberculosis its virulence and its specific character? The general tendency of thought is at present altogether in favor of a parasite, which, in spontaneous tuberculosis, is introduced into the organism by the air-tubes, or the digestive or other passages, fixes itself in the tissues and fluids, the blood especially, and undergoes evolution there, when the soil is favorable to it by a defect of resistance, hereditary, innate, or required. "M. Bouchard," says M. Debove,[4] "maintained the existence of the parasite of tuberculosis some years ago in his lectures. Afterwards, Klebs, in Germany, and Toussaint, in France, described it; but it seems clear that the parasite which they described was due to imperfect cultures. The merit of the discovery belongs to Koch, and no one can dispute his claim to it." In 1882, M. Koch isolated and colored the bacillus of tuberculosis. When this bacillus was cultivated, he found it indefinitely in generalizations in series which he effected by inoculations in animals. The demonstration would appear to be complete. The bacillus might be considered the univocal criterion of tuberculosis, and might take the place of the gray granulation, the tuberculous follicle, and the giant-cell. Nevertheless, a conclusion must not be reached too hastily. For MM. Malassez and Vignal have just declared, in a communication to the Société de Biologie,[5] that they have not found any bacilli in lesions which clinical observation and experimentation have shown to be undoubtedly tuberculous; and that they have found in them another form of micro-organism—micrococci joined in zöoglear masses. There would appear to be, then, a tuberculosis with bacilli, and a zoöglear tuberculosis; and, I would add, there are still many obscurities to be cleared up, in spite of the progress made. It is evident that clinical observation remains, up to the present time, our surest guide.

The general ideas expressed above are wholly applicable to tuberculosis of the bones. Among the most recent works in which tuberculous affections of the bones are considered in the light of the modern views, I ought to mention those of M. Lannelongue,[1] of M. Parrot,[2] of MM. Kierner and Poulet,[3] of M. Dubar,[4] of M. Charles Nélaton,[5] and of M. Ollier.[6] I shall analyze these works in the pages which follow.

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[1] Bull. de l'Académie de Médecine.

[2] Cause et nature de la tuberculose (Bull. de l'Académie de Médecine, t. xxxi. p. 211); Étude sur la Tuberculose, 1867; De la Virulence et de la spécificité de la tuberculose (Bull. de l'Académie de Médecine, Août, 1868, t. xxxiii. p. 746).

[3] Chauveau, Journal de Médecine Véterinaire.

[4] Semaine Médicale, No. 21, 1883.

[5] Gazette Hebd., Mai, 1883.

Classification and Pathological Anatomy of Scrofulo-tuberculous Osteopathies.—The want of certainty which still exists in regard to the nature of some chronic inflammations of the bones, makes it a duty not to separate them too absolutely. I shall therefore classify the osteopathies which are the subject of this work in two groups, viz: *Undoubtedly tuberculous osteopathies*, and *probably tuberculous osteopathies.* In the first category are found encysted tubercle and the tuberculous infiltration of Nélaton; the circumscribed puriform infiltration, or primary and chronic tubercle, of M. Kierner, and the diffuse infiltration, acute tuberculous osteitis, of the same author; the isolated tuberculous granulations and the confluent tuberculous granulations of MM. Cornil and Ranvier; and the generalized miliary tuberculosis of Parrot. The terminology has varied since the time of Nélaton; but his classification remains, and is sufficient. I shall adopt it. In the second category are the caries of systematic authors, spina ventosa, and perhaps the dry caries of Volkmann.

I. Undoubtedly Tuberculous Osteopathies.—The habitual seat of these osteopathies is the spongy tissue of the bones. They are found, in order of frequency, in the bodies of the vertebræ; in the extremities of the long bones (epiphysis and juxta-epiphyseal portion of the diaphysis); in the short bones of the hands and feet; more rarely in the flat bones; and exceptionally in the diaphyses of the long bones.

(1) *Encysted Tubercle.*—According to the authoritative description of Nélaton, encysted tubercle presents itself in the shape of a closed cavity containing a yellowish-white, opaque material, resembling putty. This material has a characteristic odor. It is devoid of elasticity and retains the imprint of the finger; it contains no bony particles; it sometimes exhibits marblings of a whiter or grayish tint; it is not made up of concentric layers; it spreads through water without being dissolved, forming grumous masses which float at first in the liquid, but soon fall to the bottom of the vessel. "With the microscope this dense plasma may be seen to contain a considerable proportion of tuberculous corpuscles, mixed with a large quantity of amorphous matter, and a great number of gray or yellow granules, some fatty, others calcareous." (Nélaton.) Except in terms, modern histology has little to change in this description of the French surgeon.

A *cyst-membrane* lines all the anfractuosities of the tuberculous cavity. Its thickness varies from one to two millimetres; it is gelatinous, at first soft, but afterwards increasing in consistence, while at the same time its color becomes reddish in consequence of the formation of a vascular network spreading over its surface. From this network depart a number of prolongations which penetrate the areolæ of the bone-tissue, and unite the membrane to the walls of the cavity. The internal surface of the sac is likewise shaggy ; its texture is composed of white, fibrous, inextensible, felted filaments, and represents, "in miniature proportions, the texture of the capsules of the joints." (Nélaton.) "Examined under the microscope, this membrane appears to be composed of anatomical elements like those of the matter contained in its interior." From this citation it will be seen that Nélaton had already described the process of encysting and of extension of tuberculous products, upon which M. Lannelongue has recently dwelt in connection with abscesses by congestion.

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[1] Tubercules des os, tumeurs blanches consécutives (Bull. de la Soc. de Chir. 1879). Abcès froid, et tuberculose osseuse. Paris, 1881.

[2] Du spina ventosa (Gaz. méd. de Paris, 1880).

[3] De l'ostéopériostite tuberculeuse chronique, ou carie des os (Archives de Physiologie, 1883).

[4] Anatomie pathologique des ostéites. (Thèse d'agrégation. Paris, 1883.)

[5] La tubercule dans les affections chirurgicales. (Thèse d'agrégation. Paris, 1883.)

[6] Des résections et des amputations chez les tuberculeux (Lyon Médical, 1883).

N. B. Among the recent works to be consulted, I would also mention Renaut, Notion actuelle du tubercule et de la tuberculose (Gazette Hebd., 1883). Chandelux, Des synovites fongueuses, articulaires et tendinuses. (Thèse d'agrégation, 1883.) Hanot, Des rapports de l'inflammation avec la tuberculose. (Thèse d'agrégation, 1883.) Quinquand, De la scrofule dans ses rapports avec la phthisie pulmonaire. (Thèse d'agrégation, 1883.) Schmitt, De la tuberculose expérimentale. (Thèse d'agrégation, 1883.) M. Pollonson, Note sur les formes anatomiques de la tuberculose articulaire et l'évolution clinique des fongosités (Gaz. Hebd., 1883).

I understand the series of phenomena which end in the formation of an encysted conglomerate in the following way. Bacilli or micrococci, having been introduced into the circulation, become stranded in the capillary of a Haversian canal, and set up around them the special inflammatory reaction which receives the name of tuberculous follicle, gray granulation, etc., altogether analogous to that which an inert, non-specific foreign body produces. As in every osteitis, the bone-tissue becomes dissolved ; a lacuna of Howship is created. The bacilli multiply; they invade new vessels, and provoke new tuberculous formations; other canals of Havers are involved; and so on indefinitely. By ceaseless multiplication of the parasites—a multiplication which establishes an essential difference between the perturbing action of tuberculous parasites and that of non-parasitic foreign bodies, and which explains the difference in extent and in gravity of the disorders which they respectively produce—and by the eliminative inflammation which they excite, it comes to pass that a certain part of the bone is implicated and destroyed. The central tubercles, being ill-nourished, undergo caseous degeneration, while those of the periphery preserve their character in the midst of the fibro-embryonic tissue which secondary inflammation has produced around them. This invaded peripheral portion of the bone constitutes what is called the encysting membrane. In proportion as the bacilli invade the neighboring bony layers, the most central portions of the false membrane undergo in turn caseation from being deprived of the nutrient juices, the access of which is prevented by the obliteration and destruction of the capillaries. The micro-organism of encysted tubercle is probably not the same as that of tuberculous osteopathies with a more markedly invading and acute course. It may not be the bacillus of Koch ; it may be one of its evolutionary forms, either more perfect or less advanced. It is quite reasonable to think that the different forms of tuberculosis depend upon different micro-organisms, or, better still, upon a single parasite with many metamorphoses, and which, according to its soil, goes more or less completely through the cycle of its possible destiny. However this may be, the reaction which it causes is but slight in encysted tubercle. The invading process stops, doubtless, when the general and local conditions cease to be favorable to the generation and life of the parasite. Such is my idea of the course of encysted tubercle.

There remain for us to study the bone-cavity of the encysted tubercle and the parts which surround it. The tuberculous cavity is situated either at the centre or on the surface of the bone. When it is central, the cavity is more or less rounded; sometimes it is anfractuous and has diverticuli. Its surface is usually smooth, but sometimes studded with needles of bone, which Nélaton compared to the papillæ of the tongue of a cat or tiger. Sometimes the walls are formed of "heterogeneous tissues, such as osseous, fibrous and cartilaginous." It is thus when the cavity has perforated the connecting cartilage and extended to the diaphysis from the epiphysis, or conversely; or when it opens into a joint, passing through the articular cartilage; or when, finally, it destroys the cortical layer and appears and develops under the periosteum. In the last case, the process is accompanied by periostitis with more or less abundant periosteal bone-proliferation; and in case of penetration of a joint, an arthritis arises, sometimes acute, but more often fungous and chronic.

But the distinctive characteristic of encysted tubercle is the slight degree of reaction which it sets up around it, its course being so slow and sluggish, that it may not reveal itself by any symptom during life. On making sections of all the bones in autopsies, tubercles are sometimes met with (or cysts resulting from their spontaneous cure) in persons whom no one would suspect of being likely to present them. M. Ranvier has also made the remark that tuberculous granulations, even massed in islets, may occupy extensive areas of the medulla without it being possible to suspect their existence, except from a slight discoloration of the tissue; the microscope alone enables us to affirm their presence.

Around an encysted tubercle the bone-tissue usually presents only a very slight injection, describing a reddish circle two or three millimetres in width. In children the spongy tissue being red, this hyperæmic circle cannot be recognized. In the adult, as in children, the cavity does not contain any sequestrum, and is formed by the destruction, and not by displacement of the bone-tissue. The same is true, it will be understood, of the cartilaginous and fibrous tissues which the tubercle encounters in its development. The dimensions of the tubercle-cavity vary from five or six millimetres in diameter, up to two or three centimetres. Encysted tubercles are not generally seen in large numbers.

Encysted tubercle is not found only in the crude state; it may also be found softened. At the end of a variable time, sometimes several years, the mass becomes softened, without or with inflammation. In the latter case, the tuberculous matter will be found mixed with a greater or less number of pus-corpuscles and the peripheral irritation will be more considerable. May we not consider the forms of osteitis which are called neuralgic, or painful, to be tuberculous bone-abscesses of this kind, strangulated by the resistance of the walls of the cavity?

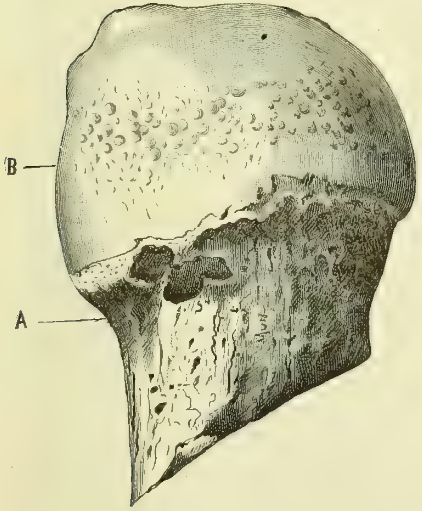
When a tuberculous abscess opens into a joint, it sets up a more or less acute arthritis; when it opens on the surface of the bone, it causes a collection of fluid under the periosteum, or under the aponeurosis, which insinuates itself in the cellular interstices of the organs, until it arrives under the integuments and perforates them. I have already spoken of the periostosis, which, according to Nélaton, in the extremities of the long bones opposes an ever-increasing barrier to the progress of an abscess on the side of the periosteum, and compels it to travel in the direction of the joint.

All osseous and tuberculous abscesses do not go on in this way until they burst externally. Non-inflammatory softening of the tuberculous material may be followed by its complete absorption. Sometimes there remains in the cavity nothing but limpid serum. Such is the etiology of some cysts in the bones. Ossifluent abscesses resulting from the softening of encysted tubercle do not always rupture; they may be absorbed and leave only a cord attached to the bone as a sign of their former presence. The classical type of ossifluent abscess is the abscess by congestion of Pott's disease of the spine. We know, from the researches of Volkmann and of Lannelongue, their mode of progress, which consists in successive invasion of the connective tissues by tubercle. The membrane is formed of proliferated and hardened connective tissue, it is crowded with tubercles which destroy it little by little as they undergo caseation and soften, at the same time that a new layer of connective tissue is invaded and proliferates.

The encysted tubercle which we have studied in the crude, indolent state, and in the state of softening with ossifluent abscesses extending to the joints or not, may also be met with in the state of cicatrization and cure. I shall not refer again to cysts which are the residue of cured tubercles. I wish to speak now of a more common and also a more happy termination. Justifying the definition of Grancher: "an inflammatory neoplasm with a fibro-caseous tendency," encysted tubercle, after having voided its softened products, may become the seat of a connective-tissue proliferation, abundant and vigorous enough to fill the cavity with granulations, the tufts of which, purged of all tuberculous elements by inflammation, lose by degrees their rich vascularity, and are transformed into stable fibrous tissue. This is a mode of recovery by no means rare. It may be favored, in some cases, by approximation of the walls of the bone-cavity in consequence of a pathological spontaneous fracture, as occurs sometimes in Pott's disease, when the body of the vertebra has been reduced to a thin shell. So far from trying to hinder this form of fracture, it should therefore be favored and directed.

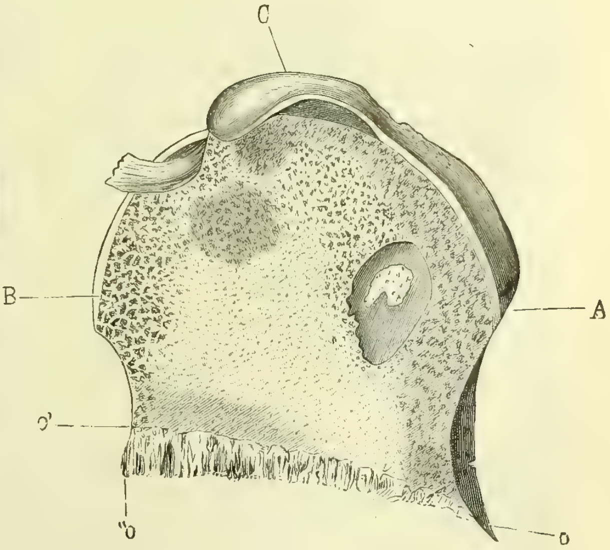
(2) *Tuberculous Infiltration of Nélaton; Confluent Granulations of Ranvier.*—"Some authors have had an imperfect idea of this form of tuberculous affection of bones, but none of them have described it." Nélaton, who wrote these words, admits however that Nichet, of Lyons, mentioned in some of his observations the presence of caseous matter in the spaces of the spongy

Fig. 1443.



Head of the femur after resection. B, diarthrodial cartilage showing multiple warty prominences. At the upper part is a more considerable elevation produced by fungating masses, which are well seen in the next figure. A, neck of the femur. Between the head and the neck is seen an excavation, which was filled with fungous masses, and which communicated with the central tubercle seen in the following figure.

Fig. 1444.



Head of the femur, removed in a resection for suppurating coxalgia by Professor Ollier. A, articular cartilage, at C, elevated by fungous masses; B, rarefaction and medullization of the spongy tissue; D, D, foci of tuberculous osteitis of a yellow color; E, cavity of osteitis, containing a sequestrum surrounded by fungous growths; O, O′, O″, splintered surface of bone below the line of section of the saw.

tissue. But Nichet did not describe tuberculous infiltration systematically, as Nélaton has done. This surgeon says that tuberculous infiltration may be met with alone or associated with the first form (encysted tubercle), but that it never follows it. It appears in two different states, which may be considered as two stages of the same form, and which may be designated by the names, *semi-transparent infiltration* and *puriform or opaque infiltration.*

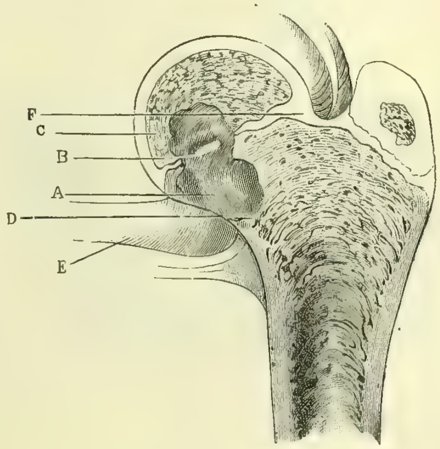
Semi-transparent infiltration is characterized by the deposit of a gray, opaline material in the spaces of the spongy tissue, which appears as if invaded by a brain-like substance. In color these spots contrast sharply with the rest of the bone. A stream of water directed upon the spaces of the spongy tissue does not drive out the infiltrated material, which sticks tightly to the lamellæ of this tissue; a very slender bloodvessel passes through them and gives them a grayish-red color. The presence of the semi-transparent infiltrate brings about no modification in the density of the bone-tissue.

Puriform infiltration, on the other hand, which succeeds the semi-transparent infiltration, "is distinguished from the preceding: 1st, by the dull yellow color of the infiltrated portions of bone; 2d, by the absence of bloodvessels; 3d, by interstitial hypertrophy of the bone-tissue." (Nélaton.) The yellow material gradually undergoes softening and becomes puriform; whence its confusion with caries. The absence of bloodvessels is one of the facts which it is most important to note, says Nélaton. The hypertrophy of the bone does not extend to its whole mass; the lamellæ of the spongy tissue are alone hypertrophied, and sometimes to such an extent that the spaces which they circumscribe are almost entirely obliterated. Nevertheless there are some exceptions to this rule. The bones of the foot or hand may be infiltrated with tuberculous matter without undergoing eburnation. Nélaton explains this breaking of the rule by the rarefaction having existed before the infiltration. If the other bones of the tarsus and of the carpus are examined, he says, they will be found rarefied, although free from infiltration. This appears to be a somewhat specious explanation. For there is no proof of the priority of the rarefaction. We know, on the other hand, that the bones near a centre of chronic osteitis or arthritis become consecutively rarefied, in consequence of the disturbance of nutrition resulting from the disease, from immobility, from the pressure of dressings, etc. It is very possible that at the beginning there is interstitial hypertrophy, and that afterwards rarefaction supervenes. The succession of absorption to proliferation is a common occurrence in affections of the bones. Different anatomical, constitutional, or therapeutic conditions may hasten or retard the succession of these phenomena. To conclude, a pre-existent osteoporosis does not seem to me certain except in tuberculous infiltrations of the bones following fungous synovitis. Then caries is present, a lesion which I look upon as an osteopathy, probably tuberculous, but which was not so regarded by Nélaton. Nélaton does not believe that purulent infiltration is always preceded by semi-transparent infiltration; the infiltration may be of an opaque yellow color from the start. However this may be, "every tuberculous infiltration in a bone is a necrosis of the infiltrated tissue." (Nélaton.)

Necrosis is the consequence of the obliteration of the vessels by proliferation of the osseous substance of the lamellæ, in a word, by condensing osteitis. Around the portion of bone thus mortified by ischæmia, a zone of eliminating osteitis is formed, which isolates it and makes it a sequestrum, and this inflammatory process persists, in a continuous or intermittent manner, until the sequestrum is eliminated, spontaneously or by the aid of an operation, from its cavity, which is lined with granulations themselves more or less infiltrated with tuberculous products (Fig. 1444). The isolation of the dead bone may sometimes be long delayed: "1st, Because," says Nélaton, "the cause which in this case produces the necrosis acts with extreme slowness; 2d, because as the inflammation continues to propagate itself to the neighboring parts, the boundary between the healthy and the diseased portion is constantly receding, so that the circle of elimination cannot form." Nélaton says that two sequestra may wear each other away if they rub together. This must be a rare occurrence, and the loss of tissue of not much importance.

Puriform infiltration gives rise to *abscesses* which make their appearance either on the surface of the bones or at the joints. But it does not generally have as an accompaniment slow abscesses by congestion, like the encysted form. The description and the considerations, of which the formation, the course, and the termination of abscesses dependent upon encysted tubercle of bone have already been the subject, apply to abscesses from tuberculous infiltration, with this difference: that infiltration usually sets up a more acute and prompt reaction. Nevertheless it sometimes proceeds by slow steps, and may remain latent for a very long time. It may happen that the centres of infiltration are discovered only by accident, at an autopsy. This happened in the case of a child, four years old, who died of tuberculous meningitis at *La Charité*, where he had been admitted for a tibio-tarsal white swelling. M. Gangolphe, wishing to know if the patient had not tubercles in other bones than those of the foot, made sections of the whole skeleton, and found in the head of the left femur, which was apparently perfectly healthy, a tuberculous nodule which appeared to be on the point of opening into the joint, which was also still free from disease. I give in Fig. 0003 a representation of this section.

Fig. 1445.



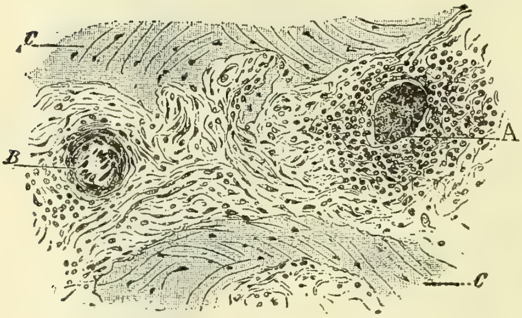
Tuberculous nodule with latent sequestrum of the head of the left femur. Child four years old. *A*, *A*, tuberculous sequestrum ; *B*, fragment of the connecting cartilage, constituting part of the sequestrum ; *C*, caseo-fibrous material surrounding the sequestrum ; *D*, lamella of bone-tissue forming the wall about to give way on the side of the joint ; *E*, capsule of the joint ; *F*, connecting cartilage, a part of which constitutes part of the sequestrum.

In spite of the presence of a portion of dead bone which was beginning to be detached, there was as yet no articular involvement. The specimen presents also an interesting example of perforation by destruction of the epiphyseal cartilage.

We have seen that during the reign of dualism—the overturning of which is in great part due to M. Grancher, and partly also to MM. Thaon and Lépine — the tuberculous infiltration of Nélaton was regarded as a simple caseous osteitis. Even now there are still a certain number of opponents of his views, among whom is M. Gosselin. Cornil and Ranvier, to mention only the most classical histologists, admit them, with restrictions which have not the significance at the present time, as far as caries is concerned, that they had ten years ago. In their view the tuberculous infiltration of Nélaton corresponds to various lesions: osteitis, caries, with caseous transformation of the medullary or purulent elements, and syphilitic gummata; but they recognize also a true tuberculous infiltration resulting from the presence in the bone-tissue of confluent tuberculous granulations. They describe these in the following way: Their size does not equal that of isolated granulations (less than from one to two millimetres in diameter), they undergo caseous degeneration, obliterate the bloodvessels which they cross, and cause consecutively necrosis and caseation of the anæmic bone-tissue, or of the medulla, when this is surrounded with granulations. According to these authors, the sequestra are not due to condensing osteitis, as Nélaton believed, but to ischæmia of the parts. The confluent granulations may give rise to both forms of tuberculosis described by that surgeon. As to the hypertrophy of the bone-trabeculæ, so peculiar to infiltration, according to Nélaton, MM. Cornil and Ranvier say that usually they undergo neither condensation nor rarefaction. They also call attention to the fact that the caseous melting down of the medulla does not extend to the bone-corpuscles, the nuclei of which become irregular in outline, it is true, but are not surrounded by fatty granulations; a characteristic which, they say, "permits the caseous transformation which supervenes upon confluent tubercles to be distinguished from that which accompanies caries."[1]

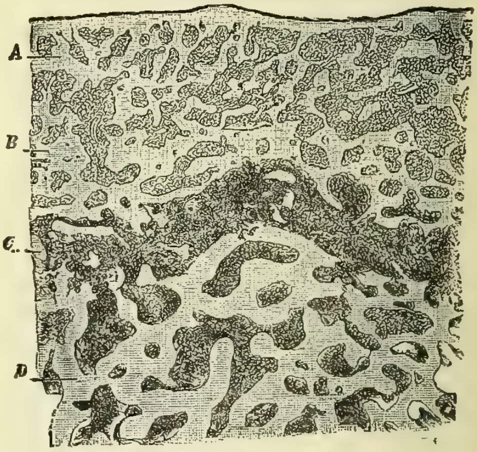
Quite recently MM. Kiener and Poulet have taken up this study, with the modern views.[2] They have demonstrated the presence of the tuberculous follicle in the depths of the bone-tissue. In their preparations one may follow the whole course of follicular development. The cells of the inner wall of the capillaries of the diseased region hypertrophy, undergo hyaline degeneration, run together, and end in the formation of a giant-cell which fills the capillary. The pathological irritation exerting its influence also on the other tunics of the vessels, the latter are infiltrated with epithelioid cells, and with embryonic cells. The follicle is then formed, and the vessel is closed. (Fig. 1446.) I give here some of the drawings of these authors. In Fig. 1447, M.

Fig. 1446.



Section of a tuberculous bone. *A*, tuberculous follicle; *B*, section of a vessel, in which is seen hypertrophy of the endothelial cells; *C*, trabeculæ of bone. (After Charles Nélaton.)

Fig. 1447.



Section through the periphery of a patch of tuberculous infiltration. *A*, sub-periosteal layer of bone dependent on distant irritation. Sometimes it is very thick, and forms a true shell around the sequestrum. This is seen, especially in children, in the region of the phalanges (*spina ventosa*); *B*, old bone; *C*, ridge of eliminative rarefying osteitis, separating the infiltrated and necrosed part from the normal tissue; *D*, the sequestrum with its hypertrophied trabeculæ. (After Charles Nélaton.)

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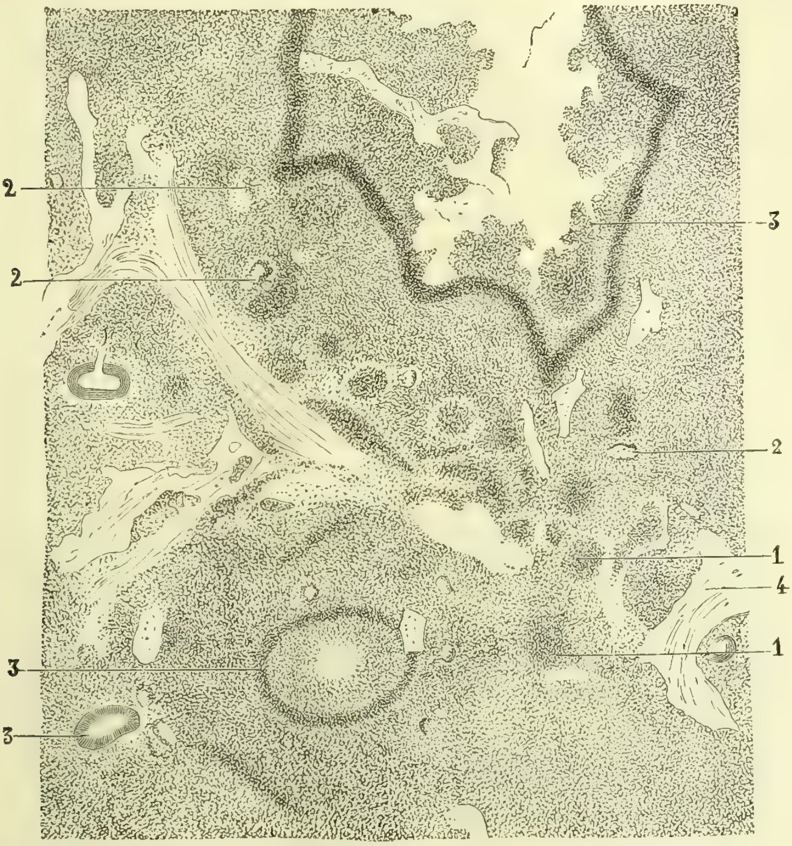
[1] Cornil et Ranvier, Manual d'Histologie Path., 1869.

[2] Kiener et Poulet, Archives de Physiologie, 1880.

Kiener has represented a section from the periphery of a patch of tuberculous infiltration. Fig. 1448 represents a section of diffused tuberculous infiltration, designated by MM. Kiener and Poulet under the name of acute tuberculous osteitis.

Fig. 1448.



Diffuse infiltration, acute tuberculous osteitis of MM. Kiener and Poulet. 1, tuberculous follicles ; 2, giant-cells scattered through the proliferated cellular tissue ; 3, cavities caused by caseous breaking-down of the follicles ; 4, rarefied bone-tissue.

The sequestrum does not always show hypertrophy ; in some cases its trabeculæ are thinned. M. Kiener has studied the histological conditions of condensation and rarefaction. In his opinion the proliferation of bone is preluded by the appearance of osteoblasts upon the trabeculæ, as in normal growth. Around these osteoblasts there is deposited bone-material, sometimes in continuous layers, sometimes in small protuberances. At still other times, the bone-material is deposited between the fibres of the connective tissue furnished by medullary proliferation. Rarefaction is brought about in two ways ; sometimes, as in the formation of a lacuna of Howship, the edges of the trabeculæ are furrowed by small fossæ with regular outlines. The work of wearing away is caused by the giant-cells—by osteoclasts, according to the expression of Kölliker—which owe their origin to a functional and anatomical transformation of the osteoblasts, according to M. Julius Busch (*osteoblasty*). Sometimes the rarefaction results from solution of the calcareous cement and return of the bone-substance to the fibrous state. It is well known that Charles Robin attributed the density of the sequestrum, not to a new formation of bone, but to a simple accumulation of calcareous salts in the areolæ of the spongy tissue and in the canals of Havers. According to Lannelongue, the hypertrophy of the sequestra is apparent only; they lose their compactness by remaining in pus or in the liquids of the cavities which contain them.

(3) *Disseminated Tuberculosis.*—In some cases there has been observed a sort of general granulation of the skeleton. In all the bones there are seen, in the midst of the marrow of the spongy tissue or of the medullary canal, tuberculous granulations in variable numbers. Isolated tuberculous granulations are, according to M. Ranvier, quite frequent in the skeleton of the phthisical. Examining the bones of persons who had died of phthisis without any apparent evidence of tubercle of the bones, Ranvier found, six times out of twenty, granulations in the adult. I am convinced that a simliar investigation in children would be even oftener rewarded with success. It is probable that, among the many cases of juxta-epiphyseal osteitis following grave pyrexias, a certain number are of tuberculous origin—are cases of osseous granuloma. Here is an open field for investigation. M. Parrot has published a case of miliary tuberculosis.

Inoculability and Parasitic Nature of Tuberculous Osteopathies.—After having shown the presence of the different histological forms of tuberculosis in the osteopathies called tuberculous, it remains, in order to complete this chapter on pathological anatomy, to prove that they are also inoculable and parasitic. The *inoculability* of the products of bone-tuberculosis is demonstrated by the experiments of Schuller, Volkmann, Hueter, König, and others. M. Ollier, in 1873, caused the successful inoculation, in the laboratory of M. Chauveau,[1] of fungous material from the joints. But I ought to mention particularly the experiments of MM. Kiener and Poulet, which have been published, to the number of ten, by M. Charles Nélaton.[2] In all cases of inoculation of the products of tuberculous bone-lesions, generalization has taken place, and the histological manifestations of tuberculosis have been reproduced in the infected animal.

The presence of a *parasite* in these osteopathies is no longer a matter of doubt. MM. Schuchardt and Fedor Krause[3] looked for it for a month in all the cases which came into the clinique of Prof. Volkmann. "The presence of the tubercle-bacillus," they say, "has been established in forty cases of tuberculosis of the bones, joints, etc. We have determined with certainty that in all cases of surgical tuberculosis it is as easy to discover the bacillus tuberculosis with the microscope, as in the sputa of the tuberculous or in the nodules of acute miliary tuberculosis." There were not usually a large number of bacilli discovered, because in none of the cases examined was the lesion found in the stage of onset, the time at which the bacilli are probably most numerous and easiest to recognize. Here is a whole world to explore. (See general remarks upon tuberculosis, p. 901 *et seq.*)

II. OSTEOPATHIES WHICH ARE PROBABLY TUBERCULOUS.—I wish to speak here especially of caries and of spina ventosa.

(1) *Caries.*—M. Ollier in his authoritative article has thus defined caries:[4] a chronic, suppurative inflammation of the bone-tissue, with a slow course, and usually progressive, without any distinct tendency to recovery, developed under the influence of an internal cause, characterized by retrograde processes which accompany the inflammatory processes, induce suppuration, and bring

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[1] Roux, Arthrite tuberculeuse. (Thèse.) Paris, 1875.

[2] Le tubercle dans les affections chirurgicales. (Thèse d'agrégation.) Paris, 1883.

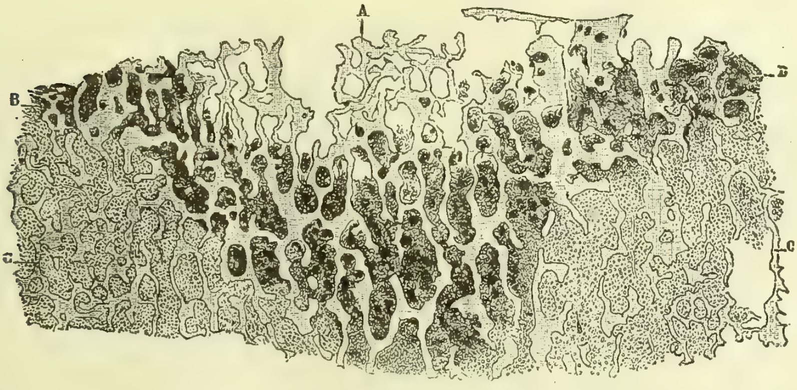
[3] Fortschritte der Medicin, von K. Friedlander, Bd. i., No. 9.

[4] Dictionnaire Encyclopédique, etc.

on successive destruction of the parts involved, either in the shape of necrosed fragments or in the shape of more or less voluminous sequestra. This affection may then be considered as an ulcerating osteitis, in this sense: that ulceration or disintegration of the portions of bone attacked by necrobiosis is its most prominent phenomenon." M. Ranvier had given, as the characteristic sign of caries, pre-existing granulo-fatty degeneration of the bone-corpuscles. M. Ollier demonstrated that these alterations of the corpuscles were consecutive and not pre-existent to the inflammation of the bone-tissue. There is nothing to be changed in the remarkable description of caries which M. Ollier has given. The question of its nature can alone be presented in a different way. I shall confine myself to presenting the arguments which at the present time seem to favor connecting caries with osseous tuberculosis, and its admission to the number of those affections of the bones to which I propose to give the name of tuberculous osteopathies.

The differential sign derived from the rarefaction or eburnation of the tissue of sequestra has no value, as we have already seen. If the sequestrum is porous in caries, this depends on the fact that the disease has developed upon prepared soil, one already rarefied. Caries almost always shows itself in the articular extremities of bones, in consequence of a chronic affection of the corresponding joint. The wasting influence of this inflammation, as well as the immobilization of the limb demanded by pain or by treatment, causes simple rarefaction, or rarefaction with hyperæmia of the epiphyses. This rarefaction explains at the same time the tendency to diffusion of the tuberculous principle in caries, and the porous condition of its sequestra, which preserve a certain vitality in the midst of the fungous tissue which surrounds and penetrates them.[1] The clinical course and the macroscopic lesions being the same in caries and in tuberculous affections of the bones, we must look to histology and to experimentation for proofs of the tuberculous nature of the former. Histology has discovered tuberculous nodules in caries. Here is a microscopic preparation (Fig. 1450), borrowed from M. Dubar.[2]

Fig. 1449.



Section showing the lesions of caries. *A*, trabeculæ of bone bathed in pus which has flowed out, leaving them bare; *D*, *B*, zone of tuberculous infiltration, the trabeculæ are slightly condensed; *C*, *C*, rarefied and hyperæmic bone-tissue. (After Ch. Nélaton.)

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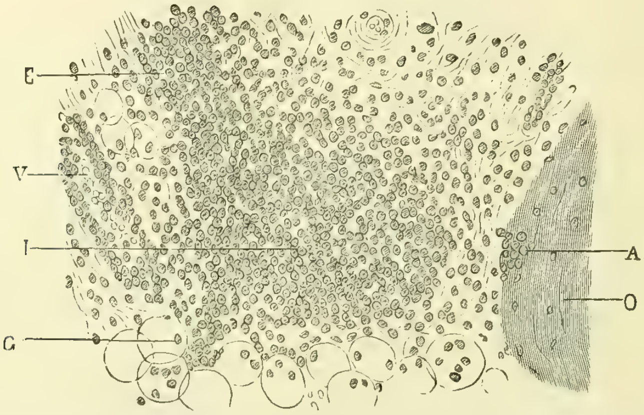
[1] Ollier, Vascularité des séquestres (Dict. Encycl., etc., Art. Carie); Traité de la Régénération des Os.

[2] Op. cit.

Fig. 1450.



Caries. *O*, bone attacked with rarefying osteitis; *A*, lacuna of Howship; *I*, tuberculous nodule with vitreous condition of the centre; *V*, vessels; *E*, network of embryonic tissue; *G*, adipose vesicles. (After Dubar.)

MM. Kiener and Poulet have found tuberculous follicles in large numbers in the sequestra of caries, in the fungous masses within and in the walls of the cavities which contain them.

Inoculation furnishes a complement to these proofs which is of considerable significance; animals have been successfully rendered tuberculous by inoculating them with fungous material from caries, stuffed with follicles. (Volkmann, Lannelongue, Kiener.) The parasite has been met with in caries; not always however. M. Cornil, who has examined fungous masses obtained from carious bone, has failed to find the bacillus in a certain number of cases.[1]

It is possible that the parasite may be a different one, and that, in looking for the bacillus, the special micro-organism of caries has not been seen. This point requires further investigation. But we may conclude even now, from what is admitted, that caries is a tuberculous affection of the bones grafted upon a chronic rarefying osteitis.

(2) *Spina Ventosa.*—Nélaton considered spina ventosa as a disease of tuberculous nature, and his view has been adopted by A. Bérard, Vidal (de Cassis), and Virchow. Gœtz[2] denies its tuberculous origin, and declares, with Volkmann, that the first occurrence is a slow inflammation of the medulla, a chronic medullitis, characterized by a fungous state of the medulla, and that there occurs secondarily a rarefying osteitis, and then a periostitis. According to M. Parrot,[3] the lesion is tuberculous. Its point of departure lies in gray nodules, which are identical with the tuberculous granulations of the lungs and other viscera.

In all the cases studied by Parrot, organic tuberculosis was found: ulcers of the lungs and of the intestines. M. Lannelongue also admits the tuberculous origin of spina ventosa; he has found the medullary tissue and the fungous masses infiltrated with tuberculous follicles, as well as the walls of the ossifluent abscesses which proceed from them. M. Heydenreich,[4] who does not consider the presence of the tuberculous follicle as sufficient to characterize tuberculosis, confesses, nevertheless, that the appearance of the lesion at its commencement, its ultimate course, and the results of histological examination, all appear to agree in justifying the opinion which sees in spina ventosa a tuberculous affection.

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[1] Dubar, op. cit. p. 99.

[2] Étude sur le spina ventosa. (Thèse.) Paris, 1877.

[3] Gaz. Méd. de Paris, 1880.

[4] Dictionnaire Encyclopédique, etc. (Art. Pathologie des os, p. 341.)

For my own part, I believe that there are two kinds of spina ventosa: one osseous, central, medullary; the other peripheral, periosteal; and that spina ventosa is always of tuberculous nature. The development of tuberculous follicles in different points of the medulla (the central canal of the bone, the areolæ of the spongy tissue, the Haversian canals of the compact tissue, the osteogenic layer of Ollier or sub-periosteal medulla of Ranvier) gives rise to the clinical varieties of this disease in cachectic patients.

The more we advance in the study of diseases of the bones, the more we see the ill effects of tuberculosis multiply. I am persuaded that the greater number of cases of periostitis and osteo-periostitis, in children and in cachectic adults or old people, are caused by deposits of tuberculigenous parasites, and by their evolution, which varies according to their peculiar nature, the soil invaded, and the part of the soil in which they collect and remain. I desire no other proof of this than the inoculations of MM. Kiener and Poulet, who have obtained generalizations of tubercle by injecting pus and fungous granulations obtained from a suppurating osteo-periostitis of the fourth and fifth metacarpal bones, from a periostitis of the ribs, and from a periostitis of the great toe.[1]

I shall consider the macroscopic appearances of spina ventosa hereafter.

SEAT OF TUBERCULOUS OSTEOPATHIES; CORRELATION WITH THE LAWS OF GROWTH.—I have already said that strumo-tuberculous osteopathies are usually situated in the spongy tissue of the bones which have red marrow; the sternum, the ribs, the bodies of the vertebræ. (Ranvier.)

Nélaton classifies the bones as follows, in regard to the relative frequency of their tuberculous affections: 1st, vertebræ; 2d, tibia, femur, humerus; 3d, phalanges, metatarsal bones, metacarpal bones; 4th, sternum, ribs, ilium; 5th, short bones of the tarsus and carpus; 6th, petrous apophysis of the temporal bone. The bones which are not mentioned in this enumeration may be classed with those with which they have the greatest analogy in shape and structure.

Nélaton thinks that tubercles occur more frequently in the bony epiphyseal nucleus than in the expanded extremity of the diaphysis. This may be true of caries following chronic arthritis, and sometimes of encysted tubercle, but in a general way the proposition is not exact, as we shall presently see.

M. Heydenreich, after having remarked that tubercles originate in the centre of the bone-tissue rather than on its surface, adds: "In the long bones, tubercles have a predilection for one of the extremities: in the femur, the lower extremity is oftener affected than the upper; the contrary is the case with the tibia; in the humerus and in the bones of the forearm the extremity most frequently diseased is that which is near the elbow."

Nothing could be more true; but what is the reason? The laws established by M. Ollier in regard to the growth of the long bones, in regard to the respective part played by each extremity of the bones in this growth, alone account for the elective localization of morbid processes in the bones. He has demonstrated[2] that the long bones increase principally on the diaphyseal side of their connecting cartilage, and that, in the same bone, both connecting cartilages do not take an equal part in its growth; the tibia grows chiefly by its upper end; the femur by its lower end; the humerus by its upper end; the radius by its lower end, etc. He has shown, besides, that morbid processes, neoplastic or inflammatory, are implanted where physiological life is most active; that they ought to choose, and do choose by preference, the parts of the bone which contribute most to their growth.

Clinical experience verifies every day the justness of these principles, which throw a most valuable light upon the whole subject of osseous pathology. "I long since demonstrated," says M. Ollier,[1] "that in childhood and adolescence, in other words, during the whole period of growth of the skeleton, the juxta-epiphyseal portions of the shafts of the long bones, that is to say, the terminal portions of their diaphyses, were most frequently the seat of the various acute or chronic inflammations, and, in general, of the different neoplasias whatever their nature. The greater nutritive activity of these portions of bone, during all the period of formation, explains their proneness to become the seat of morbid processes. It is by the extremities of the diaphysis that the bone grows, it is here that occur transformation of the layer of cartilage and development of osteoblasts, and finally the formation of the very vascular spongy tissue; in this very vascular spongy tissue also is expended the force of blows, of exaggerated compressions, and of articular distentions, and in it tuberculous neoplasias are preferably manifested."

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[1] Charles Nélaton, Thèse, p. 127.

[2] Ollier, Traité Expér. et Clin. de la Régénération des Os.

"These affections of the bones are usually, in children, the origin of affections of the joints. . . . . The invasion of the joint is dependent upon the relation of the synovial membrane to the juxta-epiphyseal region. In the shoulder, in the ankle, in the wrist, osteitis remains for a long time isolated; but in the hip, whenever a centre of osteitis, tuberculous or otherwise, is developed in the neck of the femur, there is soon an invasion of the joint, for the neck, the upper extremity of the diaphysis, lies within the joint itself."

M. Ollier does not deny the formation of tuberculous centres in the epiphyses; for he says: "The epiphyses are themselves the seat of these centres of primary osseous inflammation, but less often than the juxta-epiphyseal portions of the diaphyses. Nutritive activity is much less pronounced in the epiphyses than in the corresponding parts of the diaphysis." M. Ollier admits, with M. Volkmann, that a large number of cases of arthritis are of osteopathic origin. But he believes that primary tuberculous synovitis is much more frequent in adults than is acknowledged by the eminent surgeon of Halle.

The laws of growth apply equally to the flat and short bones. The parts bordering on their cartilages of growth are also the most exposed to tuberculous or other spontaneous inflammations (calcaneum, ilium).

In all the bones, the tuberculous affection may not produce any marked effects, or it may give rise to inflammation, to sessile or pedunculated abscesses, to periosteal hyperostoses, to more or less invaginated sequestra, to arthritis, etc.

I ought to mention some peculiarities of certain bones. In the flat bones, tuberculous lesions have a tendency to assume an ulcerating character; the bones may even be completely perforated. (Lannelongue.) The iliac bone quite often shows these perforations. They are also seen in the cranium. Rilliet and Barthez have reported a series of cases of tubercle developed upon the vault of the cranium, upon the upper wall of the orbit, in the sphenoid, the ethmoid, the mastoid process, and finally in the petrous bone. Recently Volkmann[2] has described a lesion of the vault of the cranium which he considers tuberculous, and designates by the name of *perforating tuberculosis of the vault of the cranium.* He has seen it twelve times in the frontal or parietal bones. Limited to a single part of the cranium, never exceeding in extent the size of a *franc* piece, it is characterized by caseous degeneration followed by suppuration, by separation of the periosteum and of the dura mater, and by necrosis of the bone in its whole thickness. I question if these were not cases of syphilis rather than of tuberculosis. Kraske,[3] on the other hand, has related two cases of Reid's, where the tuberculous lesion of the cranium was multiple, and accompanied by tuberculous lesions in almost all of the organs—a circumstance altogether in favor of the tuberculous nature of the process.

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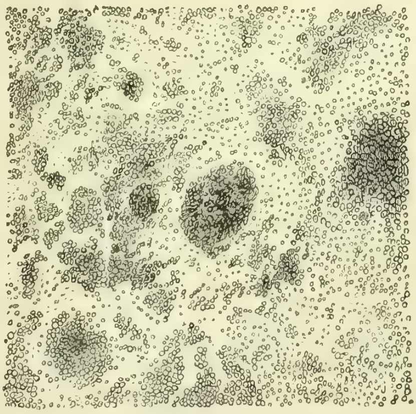
[1] De la résection de la hanche (Revue de Chirurgie, Mai, 1881, p. 383).

[2] Centralblatt f. Chir., 1880. No. 1.

[3] Ibid., No. 19.

Tuberculosis of the phalanges, and of the metacarpal and metatarsal bones, assumes, on account of its situation, an altogether peculiar form, which is suggested by the name *spina ventosa* which has been applied to it. *Spina* calls up the idea of the pain which is compared to that of the pricking of a thorn; *ventosa* indicates the blown-up appearance of the bone. The pain is sometimes absent, the swelling is constant. The fusiform swelling of the bone is due, either to the collection of pus under the periosteal sheath which is detached in its whole length, and attached to the bones by its two ends alone, or to subperiosteal bone-formations, the bulging shape of which is due to the same conditions of the periosteum. One of the most curious peculiarities of this tuberculous osteitis, is that, while new layers of bone are being laid down on the periphery, the old bone empties itself from within outwards, until it hollows out for itself a large cavity, full of fungous and gelatinous marrow, crowded with tuberculous elements. There may be also some points of suppurating periostitis in this bony form of spina ventosa, and it is at these points, where the periosteum is destroyed, that sequestra are seen to form, and afterwards perforations, leading to the central canal. Ossifying or suppurating periostitis outside, rarefying osteitis inside, such is the double morbid action which characterizes ordinary spina ventosa. Islets of the spongy tissue, and even of the diaphysis, may become necrosed, either by suppurative destruction of the periosteum, or from the more rapid invasion of the micro-organisms at certain points, or from both causes at once. Sometimes extensive sequestra are formed. Usually the joints are not affected; and usually, also, the shell of periostosis finally becomes perforated, when abscesses soon form openings in the skin which give vent to pus and to fungous masses coming from the centre of the bone, and which permit its exploration. Spina ventosa is most frequently met with in the hand, especially in the middle finger (the first phalanx) and its metacarpal bone. In the foot, the first metatarsal bone is oftenest attacked. Parrot and Volkmann, in exceptional cases, have seen spina ventosa in the ulna. It is also exceptional to see this affection of the bones in adults and old persons, but I have, in one week, seen two exceptions of the sort. One in a woman sixty years old, who had an ulcerated spina ventosa of the first phalanx of the right ring-finger, so fungating that I had to amputate it; the other in a man thirty years old, who has a spina ventosa of the first phalanx of the right middle finger, with slight involvement of the joint between the first phalanx and the second, and a painful point on the anterior surface, where spontaneous opening is likely to occur. It is to be remarked that in both cases the course has been slow; for, in both patients, the spina ventosa has lasted almost two years. M. Lannelongue refers to tuberculous gummata (Brissaud and Josias) on the arms of children affected with spina ventosa. It is reasonable to suppose that dissemination of the tuberculous material, the micro-organisms, has taken place by way of the lymphatics. Tuberculous

Fig. 1451.



Tuberculous adenitis following an osteo-arthritis of the same nature.

affections of the joints and of the bones being entirely analogous, it is proper to say here, in support of the hypothesis of this mode of propagation, that, in an autopsy made at the clinique of M. Ollier, it was possible to trace the tuberculous infiltration of the lymphatic system even to the pelvic ganglia, after a white swelling of the ankle. M. Gangolphe, chief of the clinique, following up this subject, has collected a large number of cases of tuberculous osteo-arthritis in which the swollen efferent ganglia were found to be tuberculous. He believes that, in the generality of cases, adenitis following fungous articular or osseous lesions has this specific character. He has recently had a new opportunity to verify this remark, in a woman for whom I amputated a thigh for a white swelling of the knee. At the dissection of the limb I found a small popliteal ganglion, which nevertheless disclosed the same tuberculous elements as the fungus of the knee, and quite typical, as may be seen in the preceding illustration (Fig. 1451), which I owe to the pencil of M. Mondan, from a preparation of M. Gangolphe.

ETIOLOGY OF TUBERCULO-SCROFULOUS OSTEOPATHIES.—The general causes which give rise to tuberculosis of the bones are those of the diathesis itself. Contagion, hereditary predisposition, and physiological weakness, constitute the etiology common to both external and internal tuberculosis. They need not be considered here. We shall study only the part of traumatism in the production of tuberculous outbreaks in the bones. The experiments of Schuller are well known. After having rendered animals tuberculous by means of injections of tuberculous material, Schuller inflicted various traumatisms upon their joints. In his experiments he saw fungous arthritis developed, with swelling of the extremities of the bones, enlargement and vascularization of the areolæ of the spongy tissue, and sometimes suppuration. The same traumatisms, inflicted upon animals which had not been inoculated, caused only effusions of blood, the absorption of which took place in the space of eight days. These experiments prove the influence of traumatism in subjects rendered tuberculous. Clinical experience had for a long time indicated that contusions and strains were often the cause of white swelling in the scrofulous, in persons predisposed to tuberculosis or manifestly under the influence of the diathesis. M. Ollier has been led, by clinical observation and by experimentation, to describe a *juxta-epiphyseal strain* in children, a name by which he designates the whole array of lesions produced in the juxta-epiphyseal regions of the diaphyses of the long bones by violent movements of the joints. This kind of strain, hitherto but little understood, is more common than is generally believed, and is the point of departure in many cases of osteitis in childhood and adolescence, in patients who are ill-cared for or predisposed. This observation is full of instruction. One must not treat lightly blows and articular strains, which, in children, leave pain in the epiphyseal regions. For the traumatism, if not recognized or if misunderstood, may be the exciting cause of tuberculous localization. The following is the way in which M. Ollier expresses himself on this point: "Juxta-epiphyseal strain is usually without gravity, and amounts to no more than a painful indisposition to motion which soon disappears of itself. But if the child be not taken care of, and if it be scrofulous, or hereditarily predisposed to tuberculosis, juxta-epiphyseal strain may be a frequent cause of rapid or slow osteo-myelitis, dependent on the giving way and trabecular fracture of the spongy tissue. All forms of osteo-myelitis may be the consequence of the lesions of juxta-epiphyseal strain."[1] It is moreover, as far as tuberculosis is concerned, a general fact, and one well known at the present time, that the bacilli, which remain inoffensive, even in incalculable numbers, in healthy tissues, precipitate themselves immediately upon these same tissues as soon as they are changed by inflammation, this making them a favorable medium for culture.[1] The part of traumatism is therefore incontestable in the etiology of tuberculous affections of the bones; but it must not be exaggerated, nor must all tuberculous osteopathies be attributed to a traumatic cause.

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[1] Ollier, De l'entorse juxta-épiphysaire et de ses consequences immédiates ou éloignées, au point de vue de l'inflammation des os. (Revue de Chirurgie, Oct. 1881, p. 809.)

In the preceding pages I have recalled, and appealed to, the law so justly established by M. Ollier, the law of the relation of morbid processes to the physiological activity of the cartilages of growth. It is well to add here, that traumatism effects some modifications in the clinical expression of this law, at least in inflammatory lesions.

Thus, for example, in the humerus, the upper end ought to present more inflammatory lesions than the lower end, since it contributes most to the lengthening of the bone. But, in practice, the lower end of the humerus is most frequently found diseased, either primarily or consecutively to an affection of the elbow. This depends upon the superficial position of this extremity, which exposes it to daily traumatisms, and upon the fact that the upper extremity is protected against these causes by its position, and by the thickness of the muscular covering which surrounds the scapulo-humeral region.

Age.—Tuberculous osteopathies are most common in childhood and adolescence. When they are met with in adults or old persons, they are usually relapses, or have been preceded, at a former time, by osteitis of the same nature, in other parts. Old persons with osteopathies are ordinarily persons who have relapsed. Nevertheless, scrofulo-tuberculous osteopathies are sometimes seen to appear for the first time in cachectic old persons. I have under observation, at the present time, two such cases, in patients who until now have had no disease of the bone. It is possible to become tuberculous at any age: through the bones, the skin, or the viscera. It is only necessary to offer, at any time, a suitable soil for the evolution of the parasites of tuberculosis.

Climate.—It is generally recognized that, if cold and wet climates are especially rich in scrofulo-tuberculous osteopathies, in all latitudes, yet the great centres of population and poverty furnish a considerable contingent to the statistics of this common disease of the skeleton.

SYMPTOMS AND DIAGNOSIS.—There are no symptoms peculiar to tuberculous affections of the bones, no pathognomonic signs. There may be a strong presumption that tuberculosis of the bones is present, after a thorough examination of all the conditions of the patient; but no absolute sign indicates it, unless perchance a sequestrum spontaneously eliminated has been secured and examined by the microscope, or exploration has permitted the collection of some portions of a fungous growth which the microscope has shown to be tuberculous. Except in these cases, the symptomatology gives only probabilities—up to the present time at least.

Examination of the products of suppuration in diseases of the bones, and the examination of the blood of patients and of their excretions, might, by disclosing the presence of bacilli, the specific parasites, give a pathognomonic means of diagnosis, if such a method were clinically practicable. Clinical observation enters upon this road full of the most legitimate hopes. Fergusson has made a collection of statistics, the result of which is that, out of a total of 2509 cases of phthisis, in which search was made for bacilli (most frequently in the sputa), they were found 2417 times. R. C. Smith has found bacilli in the pus of an abscess at the margin of the anus in a phthisical person, and Shingleton Smith in the urine of a tuberculous patient. Bacilli have also been found in the blood and in the expired air of consumptives.[1]

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[1] Bacilles de la tuberculose. (Revue de Médecine, Sept. 1883, p. 782.)

Inoculations in series of the blood, of the fluids of the economy, and especially of the products of osteitis, might also constitute an absolutely certain means of diagnosis; but unfortunately this plan has the drawback of demanding too much time.

By what signs shall encysted tubercle be recognized? As long as it remains in a crude state, and does not soften, its existence is not revealed by any symptom, because it does not excite any noticeable inflammation around it. At autopsies, latent tubercles are sometimes met with in the same bones which have presented phenomena necessitating either amputation or resection. Thus, for example, on section of the femur, a latent tubercle may be discovered in its lower extremity, when its upper extremity had manifested acute tuberculous osteitis. That is to say, some encysted tubercles may remain latent an indefinite time, while others promptly reach their stage of softening and of inflammatory reaction. Where the latter are present, the patient complains of more or less severe, deep-seated pain, which is increased by walking, by motion, and by pressure. In the superficial bones, like the tibia, for example, the pain is so acute that the lightest touch evokes cries from the patient. On the other hand, the process may sometimes pursue its entire course in the bodies of the vertebræ without being accompanied by any notable pain. When an abscess is formed in one of the bones of the limbs, the part swells up at this point, the skin becomes red and shining, rigors and fever appear, or not, according as the abscess is chronic or acute, and finally, when opened spontaneously or otherwise, this gives exit to ill-formed pus, bringing with it grumous masses of yellow caseous matter. The succession of these phenomena varies in rapidity, according to a number of causes; perhaps the kind, number, and virulence of the parasites, and certainly the general condition, the rest maintained, and the care received. The route by which the pus escapes remains fistulous, until the tuberculous cavity is emptied of its original contents, and filled with a healthy crop of granulations. The organization of the latter is usually delayed, because it is hindered, on the one hand, by the tuberculous granulations which still infect the cavity, and, on the other hand, by the rigidity of its walls. This furnishes an indication to clear these cavities from all tuberculous products, if they are accessible, and to stimulate them, so as to obtain an abundant crop of good granulations. The probe introduced into these cavities generally encounters no sequestrum, or only a few fragments of dead bone, which keep up suppuration until they come away. The abscesses which result from the breaking down of an encysted tubercle do not all open externally. If, instead of being situated in the superficial layers, they occupy the central part of the end of the bone, they often open into the neighboring joint. This course of events should be thought of when the surgeon finds himself in the presence of an acute, subacute, or fungous arthritis which has been preceded by well-marked pain and swelling at the expansion of the diaphysis and epiphysis of the bones making up the joint. I have already said that encysted tubercles situated in the bodies of the vertebræ give rise to so-called abscesses by congestion. I think that painful neuralgic osteitis may be only encysted tubercle in process of softening, and only accompanied by such intense, strangulating pain, because deeply situated in a tissue naturally more compact than the spongy tissue, or which has become so by surrounding sclerosis. Furthermore, these neuralgic forms of osteitis are found only in patients whose general condition is bad or suspicious.

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[1] Revue de Méd., Sept. 1883, p. 783.

The symptoms of *tuberculous infiltration* resemble somewhat those of softened and inflamed encysted tubercle. Here the phenomena of necrosis and sequestrum predominate. The course is more rapid, especially in acute infiltration, and the symptoms of eliminative reaction are more accentuated in intensity and in extent. The probe generally falls upon a sequestrum, giving a clearly defined sound, but less dry, less shrill, because of the surrounding fungous masses, than that which it gives in striking against a sequestrum of phlegmonous periostitis. Multiplied and recurring abscesses, with fistulous tracks, are still more common in tuberculous infiltration than in encysted tubercle. Suppuration is brought on by the presence of one or more sequestra. The process being diffused and continuing to progress, while the parts which die first are being isolated by rarefying suppurative osteitis, other parts, if the general condition does not improve, are being invaded, die in their turn, and give rise to a new outbreak of eliminative osteitis.

Inflammation unceasingly relighted furnishes unceasingly to the bacilli the conditions necessary for their indefinite generation. Hence the persistence of these centres of suppuration, lasting for years, sometimes for a lifetime. We see every day adult or adolescent patients come into our wards, with suppurating osteitis dating back four, five, and ten years, and cases have been reported of still longer duration. I have operated upon a young man who had had for fourteen years a suppurating centre of fungous, juxta-epiphyseal osteitis.

In cases in which *caries* follows fungous synovitis, its symptoms are mingled with those of white swelling. The articular extremities are swollen by œdema and by proliferation of the soft parts; movement of the joints gives the characteristic crepitus which results from rubbing together denuded bone-surfaces. The fistulæ lead down to rugous and friable surfaces, or to a layer of fungosities which must be passed through before the bone is reached. The tearing of the fungosities always causes a slight bleeding in these explorations. The probe often meets with detached particles, or more or less voluminous sequestra, in the midst of these fungosities. These sequestra have the peculiarity, that they are light and porous, because caries, as I have said, succeeds an arthritis or a fungous synovitis which, by rest, by inaction, or by vascular or nutritive disturbances, has caused fatty rarefaction of the epiphyses or even of the entire bone.

The sequestra of caries have their peripheral alveoli filled with fungosities which connect them with the fungosities of the cavity in which they are contained, and they preserve by this means a certain degree of vitality, to which they owe the power of becoming again medullized, of diminishing in size, and even of disappearing. The probe also reveals diminution of resistance in carious bone-tissue which is not yet dead nor formed into a sequestrum. By pushing it in with moderate force there is obtained a parchment-like crackling, which results from the breaking of the thinned osseous trabeculæ. (Billroth and other authors.)

The formation of abscesses and fistulous tracks presents nothing to be particularly noted in tuberculosis of the bones. Sclerosis and periosteal hyperostosis may often be observed around a patch of caries which is on the road to recovery, but to a less degree than in simple tuberculous infiltration with an acute or subacute course. The swelling of the limb seen in caries, at the level of the diseased part, is due rather to inflammatory œdema than to bone-proliferation caused by irritation of the periosteum at a distance. A certain part of the apparent swelling must be attributed to wasting of the limb above and below, by atrophy of the muscles which are condemned to inaction.

Caries has an indefinitely progressive course, if it be let alone. Nevertheless, in children, caries may be spontaneously cured after elimination of the sequestra and transformation of the fungosities, under the influence of a better alimentation. M. Ollier speaks of the possibility of the recovery of caries by the absorption of the necrobiotic and even purulent products, especially in young patients.

Volkmann has described, under the name of *dry caries*, a bone lesion which he has seen in the flat bones and also in the long bones, especially at the upper end of the humerus. It leads to perforation of the flat bones; and when it is seated in the diaphyses of the long bones it may bring about a true solution of continuity of the bone, a spontaneous pseudarthrosis.

> "Instead of the luxuriant tissue of deep red, or œdematous and quivering granulations, which is ordinarily seen, and which leads to destruction of the subjacent bones, there is found a moderately thick layer of a tissue which is very deficient in vessels and almost cartilaginous, and which adheres closely to the bone-tissue. What is especially characteristic of dry caries, is that at a very early period the articular cavity is obliterated by the limited and dry granulation-tissue which, starting from the synovial membrane, extends between the bony surfaces and causes them to adhere together. The process is essentially local; there is absolutely no lardaceous thickening or production of osteophytes. Atrophy of the bone and deformity of the joint are the true characteristics of this affection. There is ordinarily neither suppuration nor fever; spontaneous pain is also rare. The general health remains excellent."[1]

I do not know what to think of this caries which reveals itself neither by pain nor by abscesses. I should not be surprised if histology should some day place it among tuberculous affections. It may be a sort of indolent tuberculosis tending to sclerosis of the vegetations without provoking suppuration. Its parasite is perhaps not the same, or it may be found in peculiar conditions. M. Ollier, who has seen some cases of this kind, expresses himself in regard to them in the following manner, in his article on *caries:* "But these lesions do not appear to me to be caries; this is a variety of osteitis which I designate by the name of atrophic rarefying osteitis. . . ."

The clinical picture of *spina ventosa* is too well known for me to dwell on it at length. M. Goetz distinguishes two stages: that of simple swelling, and that of ulceration. In the first stage, the finger, for example, increases in size, assumes a shape which has been compared to that of a flask, a radish, a spindle, etc. In the second stage, the skin, which was previously healthy, changes color, becomes tense, red, or purple; then, on the dorsal surface or on the sides of the finger, more rarely on the palmar surface, one or more points soften, give fluctuation, and ulcerate. Sanious pus flows out from the openings, which remain fistulous. When the probe is introduced into these openings, it comes down on the surface of denuded bone, if the abscess has been periosteal; or enters the enlarged medullary canal, if the abscess has started there, or in this and the inflamed periosteum at the same time. The base and edges of the openings are fungous and bleed easily, especially in the second case, which is the most common. Usually the joints are so free from trouble that the children continue to move their fingers. It is well known that portions of the phalanges, and even the whole diaphysis of a phalanx or of one of the metacarpal bones, may become necrosed. The probe will indicate the presence of these sequestra. I have already explained the mechanism of these forms of necrosis.

Spina ventosa without necrosis may recover spontaneously in the first stage. Little by little the sub-periosteal deposits of bone are absorbed, everything retrocedes, and the bone resumes its normal shape. In the second stage, spontaneous recovery may still take place, after evacuation of the purulent collection and removal of the sequestra. The presence of the latter retard recovery until their elimination. In some cases—and these cases would be more numerous but for the surgeon's intervention—the disease goes on steadily from bad to worse: the swelling increases, the openings multiply, the joints are affected, the tendons of the extensors are attacked with inflammation and become filled with fungous masses, while the flexors, which are usually not much affected, contract and determine vicious positions of the parts. In some rare cases surgical treatment is powerless to stop this process, and it is necessary to have recourse to amputation of the finger.

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[1] Volkmann, Ueber die Caries sicca des Schultergelenkes. (Berliner klin. Wochenschrift, 1867.)

M. Lannelongue has called attention to the eruption of tuberculous gummata, which is sometimes seen on limbs the extremities of which are affected with spina ventosa. The patients may have tuberculous osteitis at other points of the skeleton, and other strumo-tuberculous affections. I shall return to this soon, when speaking of the general condition. But, I wish beforehand to say a word about *perforating taberculous osteitis of the vault of the cranium.* According to Volkmann, the symptoms are the following: A cold abscess marks its onset; the opening of this abscess lets out a characteristic cheesy pus, and discloses on the inner wall casefied tuberculous granulations. "Deeper down, the bone-tissue is found to be caseous and anæmic; often a sequestrum, as large as a pea, already occupies the substance of the bone; at other times, instead of a sequestrum, a perforation of the vault of the cranium is found; and then the pus which fills it pulsates. A fistula is established after the opening of the abscess, and this fistula may extend to the dura mater. Sometimes retention of pus gives rise to serious symptoms."[1]

It is impossible to pass in review all the peculiar symptoms which may result from localization of tuberculous osteopathies in the different parts of the skeleton. The functional disturbances and the anatomical complications will be in relation with the functions and structure of the diseased parts of the skeleton, and of the organs which are near to them.

Thus far, we have considered only the local symptomatology. It is not less important to the diagnosis of the nature of osteitis, to fix our attention upon the *general condition and the antecedents of the patient.* In practice, it is by the general appearance of the patient that a diagnosis of the probable nature of his osteitis is made.

If one looks carefully at a number of patients affected with tuberculous osteitis or osteo-arthritis, two classes will be discovered. Those in one class are pale and bloated; their shape is full; their hairy development is sometimes very marked on the surface of the body, especially on the diseased limb; the cervico-maxillary region is surrounded with cicatrices of suppurating adenitis; the eyes show the marks of old attacks of keratitis and other ophthalmias. The others, on the contrary, are thin and dry, and bear no signs of adenitis or of ophthalmia. Some have the appearance of health; others show all the signs of profound cachexia. If the whole body of the patient be exposed, traces of former attacks of periostitis or osteitis are found, with cicatrices depressed and attached to the bones; of cold abscesses (if they have been large, these sometimes leave cutaneous markings like those of pregnancy); of subcutaneous gummata; of anal fistulæ; of epididymitis; of former operations, etc. This general inspection of the body should never be neglected; it is a fertile source of instruction as to the antecedents of the patient, as to his present general condition, as to complications, as to the multiplicity of the present osteitis, etc. The diagnosis of the nature of the disease is read on the skin of the patient when he is stripped.

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[1] Heydenreich, loc. cit.

Auscultation of the patient ought to follow this general scrutiny of the surface of the body. Too often there are found manifest signs of advanced pulmonary tuberculosis. In many cases there is found only blowing expiration, rough and prolonged; and sometimes also respiration is absolutely normal. I have under observation at the present time a patient who was castrated five years ago for tuberculous orchitis, and who manifests at this time osteitis of the sternum and of a number of other bones, as well as pseudo-rheumatic arthritis in several joints, but who has never had the least respiratory trouble.

In a majority of cases, questioning the patients will disclose the fact that some members of their families have died of a thoracic affection, and that they themselves have had, if they have not at this time, some lung-disease: hæmoptysis, bronchitis, or pleurisy. Heredity plays an important part in the etiology of tuberculous osteitis, which cannot be too much insisted on. But privations, poverty, bad hygienic conditions, excesses, all the causes of moral or physical debility, exercise no less influence. Heredity constitutes an innate predisposition; want of any kind, an acquired predisposition to the reception and evolution of the tuberculous contagium.

I purposely omit speaking here of scrofula, as I consider this diathetic entity an initial, mitigated stage—a period of outbreak of tuberculosis. The scrofulous and the tuberculous are candidates for pulmonary phthisis. The majority of patients affected with tuberculous osteopathies die phthisical, either before recovering from their bone-lesion, or sooner or later afterwards. A certain number of children die of meningitis, of enteritis, of tubercular peritonitis, or of acute phthisis. Outside of those cases, independent of bone-lesions, there are found commonly at autopsies numerous visceral ulcerations; tubercles, caseous masses, or cavities in the lungs; the liver is fatty; the kidneys are strewn with amyloid material. Amyloid degeneration of the kidneys seems to be less common in France than in Germany. We must not forget the tuberculous infiltration of the lymphatic vessels and glands—superficial or deep, near or remote—which are found in tuberculous osteopathies.

Prognosis of Tuberculo-Scrofulous Osteopathies.—Tuberculous affections of the bones, being a manifestation of the tuberculous diathesis or infection, have necessarily a grave general prognosis. The patient who has an osteitis of this kind is threatened with the appearance of tuberculosis at some other point in his organism, and with death from phthisis. Nevertheless, if this is the rule, there are happy exceptions, the number of which depends on the conditions in which the patients live, or may be placed, in relation to hygiene, feeding, and care. The bone-lesion is susceptible of recovery, and it may even remain the sole and only manifestation of the contagion. The relative prognosis of the different varieties of tuberculous osteopathies is not the same; the encysted form, which has more tendency to spontaneous recovery, is more innocent than infiltration. The latter is perhaps less serious than caries, in the sense that it usually involves only the bone, at least originally, whilst caries generally implies a lesion of a joint and of the elements which compose it. The seat of the osteopathy modifies the prognosis. Thus, osteitis of the vertebræ or of the pelvis, is more serious, because of the difficulty of surgical interference. Tuberculous osteopathy of the smaller long bones—spina ventosa—is usually not very serious: on the one hand, it recovers spontaneously; on the other, intervention is easy. Nevertheless, in very young children spina ventosa may be serious. The question of age is of great prognostic importance. At the two extremes of life, tuberculous osteopathies are of greater gravity.

Finally, whatever may be the variety of tuberculous osteopathy, the prognosis is influenced by the general condition of the patient, his degree of heredity, and by the number of internal or external tuberculous affections which he exhibits. M. Ollier,[1] after having established the fact that pathological anatomy has not yet been able to furnish us with an infallible means of prognostication, adds: "It is upon other considerations that a prognosis must be based; upon the course of the disease and on the nature of the soil in which it develops. There is a serious tuberculosis and a benign tuberculosis. There is a generalized tuberculosis and a localized tuberculosis. There is a tuberculosis which inevitably progresses, there is another which tends to stop of itself. The one develops itself like an infectious and fatal disease; the other produces serious. local destruction, but has not, at a certain state of its evolution at least, this invading course, and remains for a long time limited to the point originally affected. Experimental analysis may some day show us what clinical analysis has already led us to suspect, that is to say, affections of different nature among those which we now group together under the name of tuberculosis. It is probable that we confound under this name different pyogenic affections."

M. Ollier admits the contagiousness of tuberculosis, which has been so clearly demonstrated by the experiments of Villemin and of Chauveau, and which are likely to find a still more precise explanation in the investigations of Toussaint and of Koch. "But," he says, "there are already so many doubtful microbes, that it would be imprudent to accept a solution which is still only probable."

While awaiting the discovery of a demonstrable and really characteristic microbe in the blood of tuberculous persons, and until the method of experimental inoculations shall be made practically applicable, there remain for the surgeon, in order to estimate the degree of gravity of the different cases which are presented to him, only "study of the patient, study of the soil, consideration of the course of the affection based upon the reactional phenomena, and minute study of the internal organs (lungs, kidneys, intestines) which clinical observation teaches us are the usual theatre of tuberculous manifestations."[2]

TREATMENT OF TUBERCULO-SCROFULOUS OSTEOPATHIES.—The treatment ought to be directed not only by the local condition, but also and especially by the general condition, since the affection of the bones is only a manifestation of the constitutional vice, hereditary or acquired, which has engendered it.

I. GENERAL TREATMENT.—The treatment should therefore be above all medical. I shall consider this first, in order to show the importance which should be attached to it. All the means of hygiene, and of reconstructive therapeutics, ought to be employed: *Circumfusa et ingesta.*

Let us consider the former first. The question of the medium, of the habitat, leads all others. Most young subjects affected with scrofulo-tuberculous osteopathies have lived in badly ventilated, damp, cold, and dirty dwellings, in unhealthy quarters of large cities, or in the defective lodgings of poor peasants. It is also a matter of observation that, all other things being equal, cold and wet climates furnish a more considerable contingent to diseases of the bones than warm and dry climates do.

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[1] Sur les résections et les amputations chez les tuberculeux.

[2] Ibid.

From these facts results the first and capital indication, to send the patient to a milder and more sunny climate, if possible; and, in any case, to place him in an airy, warm, and wholesome dwelling. The sea-shore, in a warm climate, or during the warm season, is of great utility, from the vital excitation which it produces by means of the saline emanations, and by the motion and purity of the sea-air.

Sea-baths, generally so justly recommended for their stimulating action, ought not, however, to be prescribed without caution; for impressionable patients, and those who have confirmed pulmonary tuberculous lesions, receive from sea-baths and from the air of the sea a sort of impetus which hastens the course of the phthisis. The sea should not be recommended to persons with pronounced pulmonary tuberculosis. Life in the country, in a warm region free from winds and from fog, will be more useful to them.

With the exceptions just mentioned, the sea-shore and short sea-baths are of great service in the affections of the bones which we are studying. No one can question the advantages which have been derived, for example, from the establishments of Berk-sur-mer, in France; of Margate, in England, etc., for children affected with tuberculous surgical affections. If there is a humanitarian wish to be expressed, it is that the hospital administrations of large cites should erect at the sea-shore homes for this interesting class of patients, and that in future they should build hospitals for children outside of the cities, in extensive grounds, well planted, and protected against cold winds, realizing all the conditions required by hygiene and needed for comfort. When it is impossible to ask from the sea its vivifying influence, sea-baths may be replaced by artificial salt-baths, and better still, by natural saline mineral waters, like those of Saline and Uriage. Good results may be secured from the effects of mixed baths, composed of sea-salt and of sulphate of potassium. When the use of baths is contraindicated by the weather, or for various reasons, general frictions of the body with different stimulating liquids may be employed. Baths, frictions, fresh air, sunlight, saline emanations, have for their object to whip up, as it were, the whole economy, by excitation of the skin and of the respiratory mucous membrane, so as to quicken the functional activity of the languishing organs, and thus to substitute an active and productive life for a languid and sterile one.

But if, in order to obtain greater speed in a locomotive, it is necessary to burn more fuel, it is also necessary to have richer food for an organism the renovation of which is desired. Feeding sometimes brings about astonishing metamorphoses, even in hospitals. Poor wretches, who have previously had only insufficient and unwholesome nourishment, finding there wholesome and abundant food, with a good warm bed, become transformed in a little while, gaining flesh and color. It is well to supplement food with a generous supply of good wine.

Cod-liver oil, iodine, the protiodide of iron, arsenicals, the different preparations of phosphate of lime, etc., are the tonic medicines to which recourse must be had, after improvement of the diet and amelioration of the hygienic surroundings. But, I repeat, fresh air, sunshine, good food, and sea-baths generally do more for children affected with scrofulo-tuberculous osteopathies than all the remedies which can be lavished upon them in a hospital. Bonnet's splints and invalid-carriages make it possible to extend the advantages of air and sunlight to patients whose bone-disease prevents them from walking.

As to internal remedies (creasote, phenic acid, salicylic acid, sulphate of quinine, bromine-water, oxygenated water, etc.) which have for their object the extinction of the tuberculous virus in all the tissues, its sterilization or destruction, practice and experimentation have demonstrated their uselessness up to the present time. I will only speak of experimentation. MM. Parrot and Martin[1] have subjected tuberculous matter to the action of the various known parasiticides. They have reached the conclusion that the vitality of the microbe, comparable to reviviscent animals, is considerable, greater than that of the microbe of charbon; and that in therapeutic doses the known antiseptic agents, mentioned above, are incapable of destroying it. Heating to 100° C. (212° F.), and above, alone sterilizes the tuberculous virus. "The sole agent which germs cannot resist for an instant, whatever they may be, is fire."[2] This remedy is obviously inapplicable to internal lesions. With the object of preserving from contagion persons who live with tuberculous patients, MM. Parrot and Martin propose to subject, from time to time, the furniture and the flooring to a current of air heated to about 125° C. (257° F.), by means of tubes to conduct it as irrigating tubes conduct water. It is to be feared that over-logical minds might propose from time to time to burn the house. In this case barrack-hospitals would become the ideal. We must acknowledge that therapeutics and prophylaxis are as yet of no use, and that only hygiene and good feeding enable us to contend, often indeed with advantage, against the tuberculous virus.

II. Local Treatment.—General treatment, the outlines of which I have just traced, aids powerfully in the cure of tuberculous osteopathies, and by itself sometimes secures it, but not always; and it is usually necessary that local treatment, direct treatment of the external lesion, should lend its assistance.

Before speaking of local treatment, I ought to say what is the natural course of external tubercles, either in an otherwise healthy subject, or in one with pulmonary tuberculosis: (1) They may, as Charles Nélaton says, "*recover* by surrounding themselves with a fibrous new formation or by themselves undergoing a true sclerosis, gradually eliminating the degenerated and caseified products; (2) they may remain *stationary*, at whatever stage they may be; (3) they may pursue an *extending* and locally invading course. But, in all these three cases, the disease, which at first was local, may become generalized. When surgical lesions develop in a patient who already has tubercles in his lungs, the same terminations may be seen, although here the spontaneous course toward recovery is less frequent."[3] External tuberculosis may end in spontaneous recovery, whether present alone or accompanied by similar lesions in the viscera. If spontaneous recovery takes place by absorption of the tuberculous masses and by sclerosis of the connective tissue which takes their place, or by elimination of degenerated and caseified products, the surgeon ought to endeavor: 1st, to favor absorption and sclerosis of the tuberculous masses by substitutive irritation; and if he cannot obtain this, 2d, to hasten the elimination of the degenerated products by removing them, or to destroy them where they are found, at the same time provoking a frank inflammation of the surrounding tissues which are still healthy, or which have undergone retrogressive modifications to only a slight degree.

(1) *Means designed to favor absorption of the products of tuberculous osteopathies.*—Encysted tubercle is the only form in which recovery can occur without elimination. The absorption of abscesses by congestion, of vertebral or other origin, cannot be denied. The majority of surgeons have observed the disappearance of ossifluent abscesses without operative interference, espe-

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[1] Recherches expérimentales ayant pour but de transformer le tubercule vrai ou infectueux en corps étranger inerte; 2e mémoire (Revue de Médecine, Oct. 1883).

[2] Ibid., p. 828.

[3] Op cit., p. 140.

cially in children and adolescents. When the patient refuses to be operated upon, or when there is any hope of securing absorption of the encysted tuberculous products, recourse may be had to the measures which I am about to describe. I have just mentioned the importance of general treatment. Great attention must be paid to this. It is in cases of this sort that sea-air and sea-baths are especially indicated, provided that the lesions are not very extensive and not painful, that the abscess is not large, that the lungs are almost intact, and that the tuberculosis is sluggish in its manifestations. Cod-liver oil ought to be insisted upon, and the phosphates, and the iodide of potassium in large doses. The excretory functions ought to be stimulated by repeated administration of purgatives and diaphoretics. Of late, jaborandi and pilocarpine have been much praised. But, for my own part, I have never seen an ossifluent abscess disappear in consequence of diaphoresis or salivation provoked by these substances. At any rate these tentative modes of treatment should be avoided if the patient is cachectic or has fever.

The local measures, capable of bringing about absorption of a tuberculous bone-manifestation and its products, are resolvent applications of the tincture of iodine, of mercurial ointment, of blisters, etc., with compression preceding, following, or accompanying the resolvent applications. Compression with wadding impregnated with extract of jaborandi, and an elastic bandage, when it can be employed, sometimes procures good results. It has been recommended also to employ actual or potential revulsion. Thus the actual cautery has been seen to conjure away an osteitis at its beginning. Combined with compression by wadding, and with immobilization, actual revulsion is to be recommended in the highest manner. How many patients owe it to this that they have not been subjected to gouging or resection. Immobilization alone may sometimes suffice to prevent the formation of an abscess or to lead to its absorption, if it is present. In case of tuberculous osteopathies of the vertebræ, I cannot recommend too strongly the plaster jacket, which immobilizes the vertebral column better than any other apparatus, while it enables the patient to enjoy life in the fresh air and in the sun, and to use his limbs. Bonnet's splint ought not to be recommended except when the abscess has opened at some point on the trunk, or when there is ulceration at the point of curvature. The plaster jacket put on in the beginning, usually prevents the formation of abscesses, and favors the spontaneous recovery of vertebral osteitis. If immobilization is indispensable in Pott's disease, it is no less necessary in tuberculous osteopathies of the parts near the joints, and of the joints themselves, as every movement increases the inflammation and pain. It is less indicated in osteitis of the diaphyses. Nevertheless, we have all seen that walking and fatigue aggravate these lesions, and that rest always brings a diminution of the pain and inflammation. Being limited and sluggish, bone-tuberculosis sometimes permits the patient to earn his living in one way or another, upon condition of giving up work from time to time. I know a man about thirty years of age, who, since he was sixteen years old, has dragged about in this way a tuberculous juxta-epiphyseal and diaphyseal osteopathy of the tibia. He stops work when the seat of disease, which has been gouged out several times already, and the fistulous tracks, inflame; then, after a few days of rest, he gets better and resumes his ordinary life.

(2) *Measures intended to hasten the elimination of the products of Scrofulo-tuberculous Osteopathies, or to suppress more or less radically the local lesion.*—I have referred to ossifluent abscesses. To follow the natural order of events, I will begin the description of the operative treatment with them. Abscess precedes fistula, and the fistula leads to the seat of osteitis. I shall therefore

occupy myself first with the ossifluent abscesses, then with the fistulous tracks, and lastly with the bone-lesions.

Ossifluent Abscesses.—Small, accessible abscesses should be opened when all hope of resolution has been lost. The course to be pursued in regard to large sessile abscesses, or abscesses by congestion, has varied very much. Formerly these abscesses, the latter especially, were considered a sort of *noli me tangere.* Antiseptic dressings and methods have completely revolutionized surgery in this matter, as in many others. Since Volkmann and Lannelongue have shown that the walls of these abscesses are filled with tuberculous matter, and since antiseptic methods dispel the danger of pyæmia and septicæmia, these abscesses, which were formerly so much feared, have been attacked boldly. Sessile and accessible abscesses may be simply opened with a bistoury, a drainage-tube being placed in the incision, which is then dressed antiseptically, in the manner of Lister. Complete evacuation of the abscess and washing out its cavity with carbolized water, is not, I think, indispensable. Simple incision and drainage have given me good results. Only cicatrization takes a longer time, and the dressing demands much care that no agent of fermentation shall enter the suppurating cavity. When the abscess is easy to reach and not in a dangerous region, when the sac is not deeply buried in the thickness of the limbs, or is not situated in cavities such as the abdomen or the thorax, recourse may be had to a more radical treatment, to scraping out or extirpation of the pocket which contains the collection.

(*a*) *Scraping.*—A sufficiently large incision having been made, all the tissue in the pocket which looks and feels like mucous membrane is to be removed by the aid of a sharp curette, until the wall of the cavity has been transformed into a bleeding surface. If the diseased point of bone be discovered—and it should be sought for—it will be proper to profit by the laying bare of the abscess to treat it, according to the case, by scraping, if the lesion is superficial; by rasping, by gouging, by resection, etc., if it is deep, as will be explained hereafter. But let me speak only of the abscess itself. After having washed the bleeding surfaces with carbolized water, or with corrosive-sublimate, salicylic-acid, or some other such solution, some surgeons close the whole completely with sutures. I think, with M. Lannelongue, that it is more prudent to place a drainage-tube in the most dependent portion of the wound.

(*b*) *Extirpation of the Sac.*—M. Lannelongue has proposed decortication of the sac. When the abscess is not too extensive, nor too full of diverticula, it is easy enough to detach its envelope by means of a blunt instrument, closed scissors, a spatula, the finger, etc. Scraping or decortication, the result is the same; the sac is removed, and its removal leaves behind a bleeding surface, less in the second case than in the first. It may be asked, with M. Verneuil, if this breaking of the vessels which encircle the region does not set up a most powerful process of auto-inoculation. This danger is perhaps not as great as might be feared; for, on the one hand, the flow of blood prevents the penetration of the tuberculous juices, and, on the other hand, the washings which are made during the scraping carry off, to a certain extent, the *débris* of the sac. *A fortiori* is this true of decortication. M. Ollier has proposed scraping with the aid of Esmarch's hæmostatic apparatus, when the region admits of it, in order to avoid the danger pointed out by M. Verneuil. It will be well, to insure the aseptic condition of the wound and to destroy the tuberculous germs which may remain there after the final washing, to powder the surface with iodoform. Internal ossifluent abscesses of the bones of cavities, such as the pelvis, the cranium, etc., require trephining; absolutely for the cranium, less invariably for the pelvis, as this cavity offers numerous ways of escape for the pus. I have seen, in the service of M. Ollier, trephining of the iliac bone, of the sacrum, of the vertebræ, give brilliant results in such cases.[1] It is certain that if the abscess of the pelvis is dependent upon a coxalgia, and if resection is indicated for this, one should never fail, during the operation, to perforate the cotyloid cavity, if it is not perforated already, to give exit to the pus in the pelvis. Drainage of the cotyloid cavity is very efficacious with the last method of resection of the hip devised by M. Ollier. I have practised a resection of the hip in these conditions, and thus far with a perfect result, and one which is the more fortunate since the patient is a young man, 24 years old, who has also a huge abscess by congestion, of vertebral origin, which has opened spontaneously above Poupart's ligament on the other side.

As for *abscesses by congestion*, if they are accessible in their whole extent, they should be treated like sessile abscesses. An abscess by congestion, of vertebral origin, cannot be subjected, it will be understood, to scraping or to decortication. There can be no question of surgical interference unless it has become accessible, either in the dorsal, lumbar, or gluteal region, or at the root of the thigh. Only simple opening, with drainage, can be applied to these abscesses. M. Lannelongue advises that all the pus should be evacuated after incision, and that a drainage-tube should be introduced as far as possible, by means of which injections of carbolized water can be made until the pocket is perfectly cleansed. On the succeeding days the same washings are repeated when the wound is dressed. The fever which follows this operation soon subsides. For my own part, I have opened a large number of abscesses by congestion without washing out the sac, and I have never seen fever follow. This, moreover, is the way which I saw employed by Lister. The washing and pressing out of abscesses cause lacerations of the vessels, which create as many mouths for the occurrence of absorption.

When the abscesses have voided their contents, and persist in the condition of *fistulous tracks*, giving vent to thick serum or badly formed pus in variable and intermittent quantity, what ought to be done? From the effect, we must advance to the cause; from the abscess, to the bone-lesion which keeps up the suppuration. The measures which have been proposed and employed are the following, in the order of their importance: (*a*) Modifying injections. (*b*) The actual or potential cautery. (*c*) Gouging. (*d*) Resection, or complete ablation of the bone. (*e*) Sometimes, amputation of the limb.

(*a*) *Modifying Injections.*—These have been employed from all time, and have enjoyed the more favor as the results of operations were more doubtful. Their object is to excite a healthy reaction in tissues the vitality of which is feeble, and to favor the elimination of degenerated parts. If the tracks are sufficiently straight, the injection has a chance of reaching the diseased bone; but if they are very sinuous, the penetration of modifying liquids will be of no real utility unless preliminary drainage has been made, as Chassaignac and M. Ollier have advised.

The liquids employed, or proposed, for these injections have been very numerous. I shall mention only those which have remained in use. The tincture of iodine, as efficacious as it is harmless, and Villate's solution, which was introduced to human medicine by Notta, of Lisieux, ought to be mentioned as in the first rank. Charles Heine attributes the cases of death noted after the employment of Villate's solution to the excess of acetic acid which it contains. For this reason he has modified the formula in the following way: Sulphate of copper and sulphate of zinc, of each five drachms; distilled water, five ounces. M. Ollier rarely uses the pure Villate's solution. He dilutes it with from two to four parts of water. One may also employ more or less concentrated solutions of nitrate of silver, of chloride of zinc, of compound tincture of benzoin, of liquid balsam of opodeldoch, of tincture of aloes, of balsam of Peru, of an ethereal solution of iodoform, of oil of eucalyptus—or simply of olive oil, as employed by Vallette, of Lyons—and of alcoholic solutions of creasote. This last substance has been experimented with in clinical surgery, with the double purpose of exciting the tissues and of destroying the tuberculous germs in them, according to the ideas of MM. Gimbert and Pidoux. The results have not shown anything remarkable. Moreover, it has been employed only after resections, in open cavities, to modify the nature of the fungous growths coming from the synovial membrane—from the soft parts, as well as from the ends of the bones. In such cases irritating injections may produce all their effect, and they are generally of great use. The same is not true in regard to unopened cavities. The injection here produces a decided effect on the sinuses only, but it does not reach—or it does so only superficially and incompletely—the diseased bone, and therefore does not modify the course of the disease. As antiseptic dressings render operations of exæresis almost free from danger, we should not lose time in using these irritating injections, even varying them. Early operation is an economy of time and of suffering for the patient, who, relieved of his bone-lesion, will be less enfeebled, and will repair his physiological losses the sooner.

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[1] Gouilloud, Ostéite du bassin. (Thèse.) Lyon, 1883.

In fact, irritating injections should be reserved for the after-treatment of operations, if fungous growths appear and retard cicatrization. Apart from this, I do not believe that irritating injections should be systematically employed in preference to the measures which I am about to mention, unless in case of a very limited and very accessible lesion, or in case of extreme cowardice or feebleness of the patient. And even in these cases I should prefer simple antiseptic washings which would have the advantage over irritating injections of not causing the patient useless suffering.

(*b*) *Cauterization of the Diseased Portions of Bone.*—Cauterization, says M. Ollier, "brings about necrosis of the carious portions; it imitates the process by which nature puts an end to caries in many cases. It has the advantage over spontaneous mortification of the diseased bone of exciting an energetic irritation, a healthy inflammation in the tissues which surround the necrosed part."

The *red-hot iron* and *caustics* are the means by which cauterization is practised. The thermo-cautery of Paquelin may be used for mild cases, and the old, larger cauterizing irons, brought to a red heat, for cases requiring energetic action. The galvano-cautery is not adapted for real service in these cases. Among caustics, I will recall the numerous corroding tablets of the ancients, and will only mention, among modern caustics, nitrate of silver, chloride of zinc, in the form of Canquoin's paste, the caustic of Filhos, sulphuric acid, etc.

Usually cauterization, whether actual or potential, does not provoke mortification of thick layers of bone, unless this is softened, and approaches, by its degree of medullization, the consistence of the soft tissues. On the other hand—and on this account I never employ them—energetic caustics may cause great and very dangerous disorders in the soft parts.

The experiments of MM. Pasteur and Chauveau upon the attenuation of viruses by heat, give very great importance to the radiation from the red-hot iron; and for this reason the old cauteries should be preferred to the thermo-cautery, as the latter gives but little radiating heat.

Starting with this fact, I conceived the idea of proposing and practising *breaming the bones and joints with extremely large cauteries.* M. Laroyenne has made the very just observation that the bones are heated more rapidly and more extensively when they are rendered bloodless with the Esmarch bandage, than when they contain their normal quantity of blood. If we desire to profit by the advantages of heat as a means of sterilizing or destroying the tuberculous virus, we must practise igneous cauterization of the diseased parts of the bone, with the precaution of elastic hæmostasis if the region permits. Actual cauterization deserves to be preferred, because the heat acts at a distance directly upon the microbes, and because it is easy of execution.

In what manner and to what extent ought it to be used: 1, in osteopathies of the diaphysis; 2, in juxta-articular osteopathies; 3, in articular osteopathies?

If the osteopathy is in the diaphysis, it is necessary, after having exposed the diseased surface, to touch it fearlessly and vigorously with the red-hot iron, applying the cautery firmly. Usually the depth of the diseased part and the presence of a sequestrum require a previous operation of sequestrotomy, scooping, or gouging, and then cauterization will be only the complement of an operation more radical than itself, and one which surpasses it in importance.

If the osteopathy is *juxta-articular*—if it is situated in the dia-epiphyseal bulbous enlargement, and consequently in the spongy tissue—cauterization will have more effect, and therefore ought to be employed with some caution. It is advised not to practise it too energetically, for fear of provoking inflammation of the neighboring joint or of the medullary canal. But as, on the one hand, the joint and the medullary canal are in many cases invaded, the one by fungous growths, the other by ossification of the medulla, and as, on the other hand, antiseptic dressings and immobilization enable us to prevent pyæmic infection, it is possible, nowadays especially, to use the red-hot iron without fear, even near the joints and the medullary canal.

Finally, if the osteopathy is *in the epiphysis*, or *articular*, cauterization loses almost all its advantages, at least for large joints in the adult. For here it is altogether insufficient. If the joint is affected as a whole, in its osseous and connective tissues, it is impossible for cauterization to reach all the centres of disease. These cases enter the domain of resection or of amputation. Gouging is no more sufficient than cauterization.

Intra-articular cauterization seems to me to be suited to large joints only when there is a simple tuberculous synovitis, or very slight lesions of the ends of the bones. I have designed an operation to which I have given the name of "*igneous arthrotomy combined with articular breaming and immobilization.*"[1] I open the joint with a red-hot iron, with a cutting thermo-cautery, or even with a bistoury, through the fungous masses; then I scorch with the red-hot iron the bleeding surfaces of the incisions, usually two in number, one on each side of the joint. When the joint is opened I bream it with enormous cauterizing irons until the fluids which escape from it are at a temperature which the finger cannot bear. The fungous growths having been cauterized and the joint having been breamed, I saturate the surfaces with iodoform, and, applying a strict Lister dressing, I immobilize the limb with a silicate bandage. The results obtained by this procedure up to the present time are very encouraging. But there can be no question of it if the articular extremities of the bone are seriously diseased. Then resection is demanded, especially in the adult. I except only the joints of the carpus and tarsus, including the wrist and the ankle, in young patients, whose bones, not hard in the healthy state, soften so fast, when they become inflamed, as to be easily divisible with the knife. Then the joints and the bones may be *tunnelled* with the red-hot iron, according to the expression and practice of M. Ollier. Cauterization ought to be tried before proceeding to a more radical operation, especially in the foot. In the hand, the great advantage of obtaining a movable limb by resection, ought to lead to choosing this operation more readily if the first cauterizations with nitrate of silver or with the hot iron do not bring about a prompt and sensible amelioration.

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[1] De l'arthrotomie ignée et du chauffage articulaire, combinés avec le pansement antiseptique iodoformé et l'immobilisation dans les synovites et ostéo-synovites fongueuses (Revue de Chirurgie, 1884).

(*c*) *Scraping the Bone*, *Trephining*, *Gouging*.—These operations attack the bone directly in order to remove from it the diseased parts. The indications are almost the same as for cauterization, according to the part of the bone affected. Scraping out a joint (*arthroxesis*) does not deserve the credit which has been attached to it of late, no matter in what way it is performed. In fact, if it is practised by passing the sharp curette through the fistulous tracks, or through incisions which do not expose the whole of the joint, it is insufficient. We are not sure of removing the whole of the diseased tissue, and we act in the dark, in a case in which intervention is not justifiable unless it attains its object with certainty.

If the joint is freely opened, we can, it is true, form a better idea of the bone-lesions, and we can no doubt practise excision with more ease and sureness; but even here intervention will miss its object, as far as the bone is concerned; for it is not enough to remove the fungous growths with the curette, and to scrape the diseased bone-surfaces, but it is necessary to remove them completely; if this be not done, osseous layers will be left behind, the enlarged alveoli of which are full of tuberculous matter. When applied to the synovial membrane and to the soft parts, scraping may, on the other hand, have the disadvantage of removing too much, and of cutting off parts which would be of use in the reconstitution of the joint. This is also M. Ollier's opinion. On the other hand, abrasion can only leave an anfractuous cavity which is ill adapted to complete drainage, and consequently exposes the patient to retention of septic liquids. For these different reasons, scraping and gouging of the joints do not seem to me to be acceptable operations, and I generally prefer resection, which is more sure to get rid of the tuberculous patches, and is less dangerous, because it leaves a cavity which is free from diverticula, and from which fluids can be entirely removed by drainage.

In cases of tuberculous juxta-epiphyseal or diaphyseal osteopathy, gouging is an operation the excellence of which no one can question. It has been practised from all antiquity. Nowadays, with the bloodless method of Esmarch, it has become a procedure of extreme ease and certainty. As blood does not flow into the wound, it is easy to follow up the fungous growths and sequestra, into all the diverticula of the osseous cavities, and to cut off the diseased parts from the walls of the latter.

Antiseptic dressings render this operation absolutely harmless. When the seat of the osteopathy has been diagnosticated, the soft tissues are to be incised down to the periosteum, and the whole is to be detached with an elevator. If there is a shell of new-formed bone-tissue surrounding a sequestrum, this shell should be opened by means of a trephine or a chisel and mallet; then the sequestrum should be extracted and the fungous growths of the cavity removed with a curette, and finally its diseased walls must be gouged off. If necessary, when the cavity is deep and the region is suitable, the floor of the excavation is perforated with a trephine for the introduction of a drainage-tube, that thus we may prevent the pus from stagnating as if in a basin.

Ought cauterization to be always combined with gouging? It appears to me that we may here distinguish two sorts of cases. Either the sequestrum is compact, hard, and isolated, in a cavity the walls of which are sclerosed and eburnated—all these circumstances indicating an effort of nature, which is very near conclusion, toward a cure—or the sequestrum is vascular, spongy, and united by fungous growths to walls which are not sclerosed, but rarefied, and which are themselves affected by the same process which has given rise to the sequestrum. In the first case cauterization is useless; the process is going on to spontaneous recovery; as soon as the sequestrum is removed, granulations of a healthy type will appear, and will more or less fill the cavity. The peripheral hyperostosis will diminish by absorption, by hardening of the connective tissue of the large canals of Havers, and by condensation of the bone-tissue. In the second case the process is not yet circumscribed, it is extending, it invades without intermission the bone-substance which surrounds the original seat of disease. Here cauterization ought to follow the extraction of the sequestrum; but it is necessary to scoop out the cavity beforehand, removing with the sharp curette, or with the gouge, the infiltrated bony walls, until healthy tissue is reached. The bloodless method of Esmarch, while it facilitates this operation, sometimes makes it hard to distinguish healthy tissue from tissue which is beginning to be diseased. M. Ollier gives it as a practical rule, to limit ablation to the parts which are clearly altered. "It is best to stop as soon as there is no more pus infiltrated in the areolæ of the medulla; it is best to leave not only that which is perfectly healthy, but also that which is capable of becoming so; parts which are simply rarefied will reorganize under the influence of the healthy irritation which follows the operation."[1]

In such a case, cauterization with the red-hot iron would be a useful adjuvant to gouging, as an irritant and as a parasiticide. Iodoform also will render marked service. There may be placed in the cavity of the bone an iodoform-gauze tent, such as is used by Mosetig, or a bag of carbolized gauze filled with a variable quantity of iodoform. One may also be content with powdering the walls and the bottom of the cavity with pulverized iodoform. I have never seen an accident caused by this substance. In case the tuberculous osteopathy is superficial and has not given rise to the formation of a sequestral cavity, scraping with the gouge, with the elevator, or with the sharp spoon, will usually suffice. According to the importance of the cases, these measures may be associated with cauterization. I have said, in speaking of ossifluent abscesses, that it is sometimes possible, in one and the same sitting, to scrape out the superficial tuberculous osteopathy, and to extirpate, or destroy by tearing off, the sac which had collected the products of tuberculous solution and of eliminative suppuration.

(*d*) *Resection or complete ablation of the diseased bone;* (*e*) *Amputation of the limb.*—When the tuberculous osteopathy is in the diaphysis, gouging will suffice in the majority of cases, and there can only very exceptionally be a question of lateral resection, or of total resection of a segment of the bony cylinder. Of course the periosteum should be preserved, in order to secure reproduction of part of the removed bone, by the periosteum or by ossifiable medulla, derived either from the canals of Havers or from the medullary canal of the cut surfaces of the bone.

When the osteopathy is in the epiphysis, the problem of exæresis will receive a different solution in different cases. When the joint is not involved, when the osteitis, although in the epiphysis, is still covered by the articular cartilage, we may now, with the dressings of Lister, subject these centres of osteopathy to gouging. The most ordinary prudence will indicate, in such a case, to immobilize the limb in a splint, or better still in a plaster dressing. I can count a number of successes obtained in this manner and under these conditions. It is possible in some cases, even in the knee, to have success after gouging through the articular cartilage and opening the joint. But for this it is necessary that the diseased part should be quite limited, and that its presence should not have provoked grave inflammatory impairment of the neighboring articulation. Such cases are rare. It is almost always necessary to have recourse to a complete resection of the joint. But when the primary or secondary osteopathy is continuous with an arthritis—when, in fact, there is present an ordinary white swelling, a fungous panarthritis—there can be no thought of anything but resection or amputation.

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[1] Carie (loc. cit.).

As resection preserves the functions of the limb, when it is done properly, according to the principles of the sub-periosteal method, it ought to be preferred to other conservative operations for joints the mobility of which is their predominating advantage, and *a fortiori* to amputation. "For white swellings of the elbow and shoulder," says M. Ollier, "it is better to resect as soon as the joint contains pus, even before the opening of the abscess." Such is the rule for the upper limb. In the lower limb, on the contrary, solidity of the joint, anchylosis, being more advantageous than mobility, there is less urgency for having recourse to resection. One should not resolve upon this operation until after having exhausted all the measures capable of procuring recovery with anchylosis: revulsion, superficial and penetrating cauterization with the hot iron, arthrotomy with the hot knife, breaming of the joint, and always immobilization. And, finally, when resection is practised in the lower limb, the surgeon should always aim to favor, either by the method of operating or by the after-treatment, the formation of solid anchylosis—*bony*, when it is possible—if not by osseous union of the resected bones, end to end, at least by the formation of peripheral periosteal bony layers, inclosing the bones in the manner of a ring.

Expectation secures, in the well-to-do classes, excellent results, even in cases of suppurative inflammations of the hip and knee. In Germany and in England, after having practised resections of the hip and of the knee to excess, there is a return to those principles of conservatism from which we have never departed in France, at Lyons less than elsewhere, where the memory of Bonnet is kept alive. Therefore, in the lower limb, the rule is never to resect until after all the resources of conservatism and bloodless treatment have been exhausted.

Independently of these physiological considerations, the choice between resection and other methods of intervention ought to be suggested by the general condition of the patient and his social position. Amputation, of which I have not spoken yet, is an extreme measure, to which we resort less and less, in proportion as we get the habit of resecting early (in the upper limb), and as by practising resection in a correct manner we are better able to derive from it the benefits which it is capable of procuring.

In my opinion, it is not fair to compare tuberculosis with cancer; because quite often a cutaneous, osseous, or pulmonary tuberculosis is recovered from, whilst recovery never, or almost never, follows cancer. To extol amputations and to practise them hastily, acting upon an erroneous analogy, is a surgical error deserving condemnation. The results of resections in the hands of my excellent teacher, Professor Ollier, have thoroughly convinced me that less is generally expected from this operation than it is able to give, and that it is going astray to attribute to the discovery of the tuberculous follicle and bacilli an exaggerated practical significance. There are degrees to the virus and to its malignity. Besides, in order to lead to the acceptance of so radical a kind of surgery, it should be possible to demonstrate that in amputating, or in extirpating everything which appears diseased in resecting a joint (the synovial membrane, the ligaments, etc.), the whole of the disease is really extirpated. M. Ollier, from facts observed in his clinique, insists upon tuberculous infiltration of the lymphatic glands situated above the diseased part, and very deep. You may indeed have amputated the thigh for a white swelling, but you cannot say that you have done a radical operation, as far as the tubercle is concerned; for you leave behind the femoral ganglia, which cannot all be removed, and also the pelvic glands, which are tuberculous. Resections and amputations will always leave behind the thoracic or pelvic ganglia, even though it be recognized as the rule to complete these operations by enucleation of all the swollen glands of the limb. If this be so, it ought to be made a rule to prefer resection to amputation, and not to decide upon the latter, except as a last resort.

If the general condition is very bad, if the local disturbances are very extensive, involving at the same time and seriously the bone and the soft parts, if there is very abundant suppuration which is causing the exhaustion of the patient, and if, at the same time, the latter is advanced in years and cachectic, amputation is a necessary sacrifice. All things being otherwise equal, considerations of fortune, of social position, of profession or of trade, will enter into the question as to the course to be pursued. In the lower limb, an amputation of the thigh or an amputation of the leg will often be more to the true interest of the patient, if he is destitute of means, than a resection of the knee or of the ankle.

Are resections or amputations justifiable in tuberculous subjects? This is the last and important question which we must ask ourselves at the end of this study. Ought tuberculous persons to be operated upon? Professor Verneuil and his pupil M. Leroux[1] have presented a gloomy picture of the results of operations on tuberculous patients. It is certain that cases may be cited in which an operation, however slight, has caused an outbreak of tubercle in the lungs or other viscera. But it is no less certain that to these can be opposed other cases in which there have occurred very perceptible amelioration and even disappearance of pulmonary lesions which existed before operating. M. Ollier has reported cases of this kind in his memoir on resections and amputations in tuberculous subjects.

On the other hand, there are quite a large number of patients who, having been subject to amputation or resection when their lungs were unaffected, have remained long years, and even to the end of their lives, without having the least tuberculous lesion in any part of their organism. In the third place, antiseptic dressings, by suppressing complications in wounds, by reducing suppuration to almost nothing, have freed the operative traumatism from the disastrous consequences which formerly followed it. The tuberculous person may die of pulmonary or visceral tuberculosis sooner or later after the operation—M. König has labored to demonstrate this, but we knew it only too well before—but an antiseptic operation will not shorten his days. On the contrary, an operation, by removing an external tuberculous centre, removes at the same time a cause of exhaustion (by suppuration, want of exercise, absorption-fever, suffering, anorexia, and insufficient assimilation), and a source of infection. Consequently, it places the patient in better condition to escape generalization of the tuberculosis, and to resist the present attack as well as future contagion. Therefore one can, and one should, operate upon tuberculous patients, whether their lungs are affected or not. I have seen, in the service of M. Ollier, patients who have had the signs of cavities, stationary it is true, much benefited by operation. The coincidence of tuberculosis of the lungs with a tuberculous osteopathy contraindicates operation only when it is malignant, when it is progressing rapidly to disorganization of the lung. Even in this case, if the pains of tuberculous osteitis or osteo-arthritis were excessive, one might, after the example of M. Ollier, operate merely for their relief. In the discussion upon this question which took place at the Société de Chirurgie, in 1878, M. Trélat laid down the following rule of conduct: It is right to operate as soon as a tuberculous lesion is recognized, whether the affection be independent of any alteration of the lungs, or developed in a phthisical patient; since, in the first case, the external lesion is cured, and the patient is enabled to build up his organism by being freed from a centre of infection; and because, in the second case: 1st, the external lesion is cured; 2d, he is given a chance to have his pulmonary lesion improve. M. Ollier, after having considered this question with the broadness of view which is habitual with him, in the memoir just cited, has formulated the following conclusions, which I shall reproduce in part:—

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[1] Des amputations et des résections chez les phthisiques. (Thèse.) Paris, 1880.

> "1st. Resections of the joints practised upon tuberculous subjects may give durable results. They make it possible not only to secure a local cure, but also to put a stop to the general disorders which have their source in absorption of the products of tuberculous centres in the joints; . . . 4th. Resections of the joints, in patients who had manifested all the anatomical and clinical signs of a tubercular affection, have enabled me to obtain recoveries which have been maintained for fifteen years and more; . . . 6th. Theoretically, amputations are a better protection against secondary infection than resections; but they never constitute a radical operation. The deep and inaccessible lymphatic glands which are already invaded by tuberculosis remain behind in both cases. 7th. Resection, followed by complete local recovery, that is to say, by final cicatrization of the wound, leaves no greater risk of secondary tuberculous infection than amputation. 8th. Hygiene and general medication are of very great importance in modifying the soil in which tuberculosis may be developed. Local modifiers may destroy the tuberculous tissues and transform them into stable cicatricial tissue; this transformation, moreover, takes place spontaneously in many patients, especially in children."

RACHITIS.

Rachitis has been already described among constitutional diseases by Dr. Lewis Smith,[1] and my task is thus much simplified; indeed, I should have had nothing to say if Dr. Smith had recognized the occurrence of rachitis after the earliest childhood. He confines himself to stating that Glisson, Portal, and Tripier, observed the appearance of rachitis near the time of puberty, and that Sir William Jenner has seen children seven or eight years old having a first attack of the disease. He himself knows of no case occurring after the first years of life, and the way in which he speaks of the observations of Glisson, Portal, Tripier, and Jenner, leaves us to suppose that only the authority of the observers prevents him from rejecting them. Nevertheless, the occurrence of this late form of rachitis cannot be denied.

RACHITIS OF ADOLESCENTS; LATE RACHITIS (OLLIER).—In my opinion, rachitis may appear at all stages of the growth of the skeleton, and its manifestations are in direct ratio to the activity of the physiological processes peculiar to the age of the patient. In other words, the younger the subject, the graver the rachitis; the greater the osteogenic activity, the greater will be its perturbations, the more marked the rachitis, all other things being equal. During the whole period of growth, the work of increase of the skeleton may be disturbed, and rachitis appear, if the conditions which give rise to it are present.

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[1] See Vol. I. page 251, *supra.*

Causes.—These conditions may be summed up in one word—physiological want, a want which may exist in the very bosom of abundance. Grave fevers, typhoid fever, measles, scarlatina, etc., often give rise to it. This is why we sometimes see rachitis appear during convalescence from these diseases. I have at least observed this of scoliosis. But besides these pathological states, there are, for both sexes, special causes which explain both late rachitis and the deformities to which it gives rise. In young girls, the preparation for, and the establishment of, the catamenial flow, often cause profound anæmia, depression of the strength, general languor, and well-marked disturbances of nutrition, the degree of which is proportioned to the activity of growth and to the social condition of the subject. If to these causes of physiological want, and of rachitis, we add the influence of a more sedentary life—one in which there is more sitting down—and the wrong attitudes which children assume in school, the frequency of scoliosis in little girls from nine to fourteen years old, will be easily understood. To me it appears that the scoliosis of adolescents is a late vertebral rachitis. Among young boys, the storms of puberty, with the debility which accompanies it, the rapid growth which coincides with this period of life, the lymphatic temperament, etc., also give rise to the same physiological want which disturbs the work of ossification and brings on rachitis. The less sedentary life of the young boy—the being more on his feet—his walking more than girls, predispose him more to the manifestations of late rachitis in the lower limbs, and especially to knock-knee, than to scoliosis. I shall hereafter give an example of late rachitis of the femur.

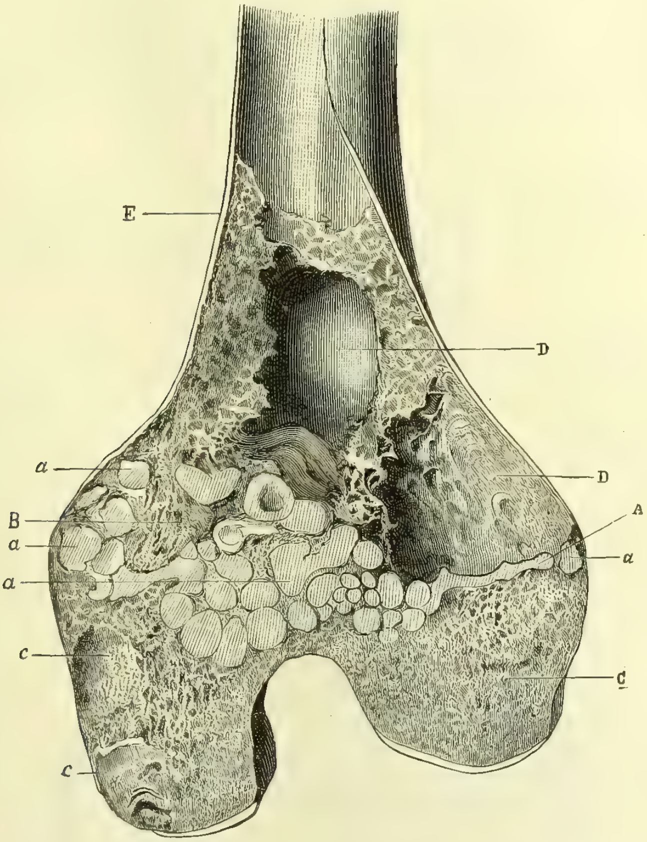
These evolutionary causes, which are common to all classes of society, and perhaps a certain predisposition, receive powerful assistance from the privations and sufferings of poverty and of bad hygienic surroundings. Poor and insufficient food, want of heat and ventilation in their dwellings, premature work, and work which exceeds the strength of young persons, explain why deviations in shape, and deformities of the limbs and pelvis, are more frequently met with in the poor and laboring classes. Mikulicz has made a curious observation. In Vienna it is especially young bakers who are affected with knock-knee. The journeyman baker is badly nourished, turns night into day, goes out but little, does not sleep enough, sweats a great deal in the exercise of his calling in the midst of an overheated atmosphere, etc. These are so many causes of debility and imperfect ossification, that is to say, of rachitis. This disease manifests itself in the baker's young apprentice preferably as knock-knee, because when he kneads the dough he puts his knees together and separates his feet, so as to have a larger base of support and to work the dough with greater strength.

Physiological want and vicious attitudes, such are the usual causes of rachitis and of the deformities by which it is accompanied in adolescents. If we should follow up the different callings and the different conditions of existence of rachitic youths, we should find the predisposing cause of the rickets as well as the mechanical reason for the bony deformities, among which scoliosis and knock-knee are the most common.

Treatment.—If knock-knee and scoliosis are dependent upon rachitis, one ought, no matter what surgical interference may be determined upon, to pay great attention to the general condition, and not to forget to prescribe the employment of phosphatic preparations, and of foods in which earthy salts predominate.

Although I do not have to treat here of the surgical therapeutics of idiopathic scoliosis, nor of that of knock-knee, I think I may in passing recommend for scoliosis the method of Sayre; and for knock-knee the *redressement brusque* of Delore, of Lyons, or, better still—especially if the patient is over fourteen years old—subcondyloid osteoclasis with the apparatus and by the method of D. Mollière and of Robin, of Lyons, the magnificent results of which are multiplying every day.

Fig. 1452.

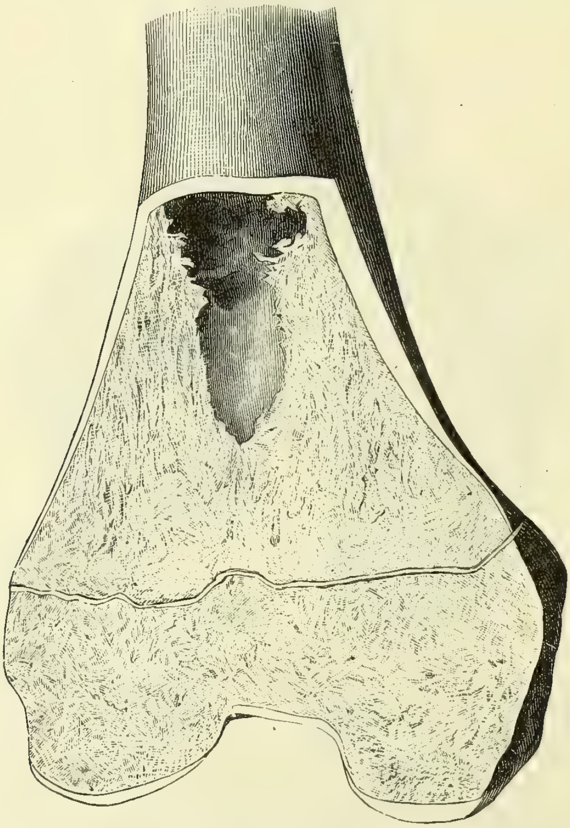


Specimen of local inflammatory rachitis of adolescents (late rachitis occurring in an inflamed bone, Ollier). Longitudinal section of the lower end of a femur, the upper end of which had been the seat of chronic osteitis in a case of coxalgia. *A*, connecting cartilage unbroken, but thicker than in the normal state; *a*, *a*, *a*, *a*, *a*, cartilaginous islets which have taken the place of the connecting cartilage and have invaded in an irregular way both the epiphysis and the diaphysis; *B*, spongy tissue which separates them; *C*, lower epiphysis, some points of which are medullized; *c*, *c*; *D*, *D*, medullized portions of the juxta-epiphyseal region of the diaphysis upon which rachitic chondro-spongioid proliferations encroach; *E*, compact tissue of the diaphysis as thin as paper, the medullary canal being very much enlarged.

Local Inflammatory Rachitis.—It remains for me to mention a variety of rachitis in adolescents which is as yet but little known, I believe, and which may be called *local inflammatory rachitis*, in order to suggest the influence under which it is produced, and its limitation to the bone or bones inflamed. Inflammation (simple osteitis, tuberculous osteitis, caries, etc.) may cause at the other extremity of the bone, that not originally diseased, an arrest of ossification at the position of the connecting cartilage, together with a defect of ossification in the subperiosteal osteogenic layers, and medullization of the old bone; whence arise the porous state of the spongy tissue and the thinning of the compact layer of the diaphysis. At the position of the connecting cartilage there is found only a thin rim of cartilage, with masses of cartilaginous nodules separated by spongy tissue and occupying a space of several centimetres. It is evident that these rachitic changes must be referred to the inflammation at a distance, to the disturbances of the circulation which it causes, and to the immobilization of the affected limb, and that they are further favored by the general malnutrition resulting from the constitutional condition and from want.

M. Ollier, who taught me to recognize this form of rachitis, has given me permission to republish the drawing made by M. Mondan, of a specimen which I found in his rich bone collection. The specimen was obtained from a young girl of fifteen years, who was treated by capillary puncture and immobilization for a suppurating coxalgia, and who, when she was almost cured of this articular affection, died in the Hôtel-Dieu with symptoms of tuberculous nephritis and meningitis. Figs. 1452 and 1453 represent longitudinal sections of the lower end of the diseased femur and of the healthy femur, so that by contrast the rachitic changes which I have just described may be better understood.

Fig 1453.



Longitudinal section of the healthy femur of the same patient.

It is probable that the lesions of rachitis are analogous in knock-knee and in the other forms of rachitis of adolescents; and that among the diseases of the bones and joints of young persons, local rachitis, caused by inflammation at a distance, is more frequent than is generally believed. The subject requires further investigation. This specimen may also be regarded as an example of rachitis combined with osteomalacia; for the cortical layer of the diaphysis was reduced to a thin flexible layer which was easily cut with the knife.[1]

Morbid Conditions in which Bone loses its Normal Consistence and Resistance; Osteomalacia and Fragilitas Ossium.

Besides rachitis, the bones may lose their normal consistence and power of resistance: (1) By true osteomalacia, general and progressive, to a certain extent malignant, usually puerperal; (2) By true osteomalacia, progressive also, but more slowly invading, to a certain degree benign (*osteitis deformans* of Paget); (3) By osteomalacia, dependent not upon any special constitutional cause, but upon an inflammatory cause which is wholly local (osteitis, necrosis with osseous new formations); (4) By atrophy of the bones (senile osteoporosis, fatty osteoporosis, etc.); and (5) By idiopathic fragility of the bones. I shall describe these different morbid states in the order of the classification which I have just given.

Osteomalacia (ὀστέον, bone, μαλακός, soft) is a morbid process of softening of bone already formed, characterized histologically by "a lesion of nutrition of the bones which ends in absorption of the calcareous salts of the bone-substance and in melting away of the bony trabeculæ" (Ranvier); and clinically, by loss of the normal hardness and resistance of the bones, and by deformities of the skeleton which are more considerable as the softening is more marked.

History and Bibliography.—The first observation of osteomalacia, according to Lobstein,[2] was made by an Arabian physician by the name of Gschusius. This physician had seen a man—doubtless the augur Satih, whom J. Reiske[3] calls the man without bones, and who died at about the time of the birth of Mahomet—a man who could move only his tongue, and who had himself carried upon a mat of palms, because he had no bones, except in his head, neck, and hands, and because the other parts of his skeleton, from his clavicle to his feet, bent like cloth. In 1851, M. Buisson collected[4] fifty cases of osteomalacia, ancient as well as modern, which had been reported by Hallerius,[5] J. Fernelius,[6] Gabrieli,[7] Prattenius (1660), Anel, Valsalva (1700), Morand the younger,[8] Pringle,[9] Ludwig,[10] Planck,[11] J. P. Franck,[12] Sandifort,[13] Wilson,[14] and others.

In the writings of these different authors, the conception of osteomalacia as a morbid entity distinct from rachitis is far from clear. All sorts of softening of the bones were confounded by the ancients. Glisson,[1] when studying rachitis in England, first marked a distinction which is supported no less by anatomy than by clinical experience, but Lobstein[2] was the first to assert the difference between osteomalacia and rachitis. Neither his contemporaries nor his successors shared all his opinions. Boyer[3] described (under the title of *Ramollissement et fragilité des os*) rachitis, osteomalacia, and senile osteoporosis. The confusion was complete. Rufz, in 1834,[4] and Guérin, in 1839,[5] devoted remarkable papers to rachitis, of which they traced, Guérin especially, the anatomico-pathological picture as no one had done before. Stanski[6] (1839) represented osteomalacia as a separate affection. In 1850, Trousseau and Lasègue advocated with their usual ability the identity of the two diseases, and Gubler expressed the same opinion. The thesis of Buisson, in 1851, was a reply to these arguments, in which genius was more conspicuous than patient study. In 1852, Beylard collected 47 observations of *ramollissement* in adults.[7] In 1861, the Gazette Médicale de Strasbourg published articles upon osteomalacia, signed by Schutzenberger and Sommeillier; and before the Faculty of Strasbourg, M. Drouineau,[8] in reference to a patient of Professor Schutzenberger, laid down the differential diagnosis between osteomalacia and rachitis. But it would delay us too long to analyze the many papers written upon this subject. I must limit myself to mentioning the works enumerated in the note.[9] With the accumulation of literature upon this question there ought not to be yet the least doubt about it. Unfortunately this is not the case. It is true that osteomalacia is not confounded nowadays with rachitis. One is a disease of adult life (decalcification of completely developed bones); the other is a disease of childhood and of adolescence (want of calcification of the proliferations of the cartilages of growth). But if an adult can only become osteomalacic, it is not certain that a child may not be at the same time rachitic and osteomalacic, or simply osteomalacic. Is the *osteitis deformans* of Paget a mitigated form of osteomalacia, or is it a real osteitis? What is the special agent of the morbid decalcification of the developed bones? What are the chemical and physical alterations of the different elements of bone? Here are some subjects for future study.

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[1] See pp. 946–950, *infra.*

[2] Traité d'Anatomie Pathologique, t. ii. 1829.

[3] Opuscula de re medica ex monumentis Arabum, Obs. 2. Halæ, 1776.

[4] Thèse inaugurale, 1851.

[5] De morbis internis, Obs. 7. Lugduni, 1578.

[6] Universa medicina; de abditis morborum causis, lib. ii. Genevæ, 1627.

[7] Miscellanea curiosa. Obs. 3, 1695.

[8] Hist. et Mém. de l'Acad. des Sciences, 1753.

[9] Philos. Trans., 1753.

[10] Adversaria medico-practica. 1757.

[11] Commentatio de osteosarcosi. 1782.

[12] De rachitide acuto adultorum. 1788.

[13] Musæum anatomicum Academiæ. 1795.

[14] Diseases of the Bones and Joints. London, 1820.

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[1] Tract. de rachitide s. morbo puerili Rickets dicto. Lond., 1650.

[2] Op. cit.

[3] Traité des Maladies Chirurgicales, 5e édition. Paris, 1844–1853.

[4] Gaz. Méd., 1834.

[5] Ibid., 1839.

[6] Thèse, 1839.

[7] Du rachitisme, de la fragilité des os, de l'ostéomalacie. Thèse, 1852.

[8] De l'ostéomalacie. Thèse.

[9] Curling, Medico-Chir. Transactions, 1837; C. O. Weber, Ossium mutat. osteomalacia univers effect. (Diss. Inaugural.) Bonn, 1851; Virchow, Archiv f. path. Anat., Bd. iv. 1852; Förster, Handb. der path. Anat., und Atlas, 1853; Rokitansky, Handb. der path. Anat., 1854; Alf. Collineau, De l'ostéomalacie en général. (Thèse.) Paris, 1859; Rindfleisch, Schweiz. Zeitschr. f. Heilk., Bd. iii.; Id., Traité d'Histologie Path., trad. par Gross. Paris, 1873; Kuhn, Parallèle entre les diverses espèces d'ostéom. (Gaz. Hebd., 1864); Vallin, Rachit. et ostéom. (Ibid., 1865); Volkmann, Hand. v. Billroth u. Pitha, 1865; Virchow, Pathologie Cellulaire, trad. par Picard, 4^e édition. Paris, 1874; Ranvier, Considér. sur le Dév. du Tissu Osseux. Paris, 1865; Cornil et Ranvier, Manuel d'Hist. Path., 1869.—Souligoux (Piorry), Ramollissement des Os, 1866; Ch. Robin, Comptes rendus de la Soc. de Biol., 1850, et Gazette Méd., 1851; Broca, Sur quelques points du rachitisme (Bull. Société Anat., 1852); Follin, Traité Élém. de Path. Externe, 1869; Nélaton, Éléments de Path. Chir., 1844, 1869; Dupuytren, Leçons Orales; Cruveilhier, Anat. Path. du Corps Humain. Paris, 1830–1842, in-fol., et Traité d'Anatomie Pathologique Générale. Paris, 1849–1864; Kilian (de Bonn) 1849 à 1857; Winckler, Roe, Calderini, Cazeaux, Crowhurst, 1870; Casati, Furstenberg, Wilmart, 1871; Barnes, Hugenberger, Ketzmawrsky, Krassowsky, 1872; Gurtler, Hennig, Weber, Ebenhoff, 1873; Bouley, 1874; Langendorff und Mommsen, Beiträge zur Kenntniss der Osteomalacie (Virchow's Arch. f. path. Anat, Bd. lxix. 1876); Fasbender, Fehling, Banks, Mader, 1878; Feist, Grenser's Lehrb. der Geb.; Id., Nægele et Grenser, Traité de l'Art des Accouchements, 2^e édition, par Aubenas et Stoltz, p. 502. Paris, 1880; Atkins, 1880; Demange, Ribbert, 1881; Bancroft, Wolff, Rehn, 1882; Gusserow, 1883; Alph. Charpentier, Traité des Accouchements. Paris, 1883.

Pathological Anatomy.—I shall divide this study into three parts: 1st, physical properties; 2d, structure; 3d, chemical analysis.

1. *Physical Properties.*—The description of the physical properties of bones affected with osteomalacia includes: (1) their external appearance and the changes in their power of resistance; (2) the changes of direction which they undergo, in other words, deformities of the skeleton.

(1) *External Appearance and Changes of Power of Resistance.*—In mild cases, the bones may preserve their normal dimensions and color. But in typical cases it is said that their size and their color undergo alteration. They are grayish, dark brown, even purple. Some authors, Stanski among the number, have mentioned, as a constant occurrence, increase in size of the long bones and especially of their extremities, as in rachitis. This increase in size does not appear to me to be so common; it ought to be present when reparative processes have taken place under the periosteum, while chronic inflammation has caused absorption of the deep layers. Bulbous enlargement is not likely to be present except in young patients attacked with the malady during the period of growth. It is not possible for me to mention all the cases in which this enlargement has been observed. I will give only one as an example. Souligoux[1] mentions an enlargement near the head of the humerus. In analyzing this case, it is seen that the patient, who died at the age of 18 years, must have begun to be ill when about 15 years old, and that when about 6 or 8 years old he had a curvature of the spine. In his case the bulbous enlargement would seem to have been attributable rather to rachitis. I see no incompatibility in the coexistence of rachitis and osteomalacia. Why could not the same constitutional cause, during the period of growth, at once prevent calcification of the osteoid products of the cartilages of growth, and provoke decalcification of the bony parts already formed? I believe that this double action would be the more intense as the preformed bone was more recent, that is to say, the younger the patient was. The uncertain ideas which used to be held in regard to the growth of the bones lessens the value of the old observations. I have not found mention of these juxta-articular enlargements, in adults, in any recent observation. See, for example, the cases of Czerny, Langendorff and Mommsen[2] (man of 38 years); case of M. Mondan[3] (woman of 48 years); case of M. Wolff (man of 26 years). As to the increase of size of the body of the bones, it may be admitted, strictly, that it may sometimes be real, that is to say, may result from subperiosteal proliferation. If, as everything seems to lead us to believe, osteomalacia is a kind of progressive chronic osteomyelitis, it is easy to understand this increase. For peripheral increase is one of the well-known signs of chronic osteomyelitis in general. In the cases which are usually examined, the processes of absorption and central medullization have reached their extreme limit, that is the disappearance of all bone-substance, old or new. It is only in cases of slight and localized osteomalacia, in which the process remains in a manner in the stage of onset, that a real increase in size of the body of the bone can be noted. If the cases published by Sir James Paget under the name of *osteitis deformans* are, as I am disposed to believe, slight and benign manifestations of osteomalacia, they furnish proof of the possibility of an increase in size of the bones in this disease. In the forms of osteomalacia which I call malignant—in contrast to *osteitis deformans* which does not lead to death, while classical osteomalacia is almost always fatal—the increase in size is only apparent, and is merely the result of the bendings and breakings which heap the bone upon itself. Usually, if there is still a shell of bone, with but few fractures, the bone will appear thinned rather than thickened.

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[1] Op. cit., p. 114.

[2] Loc. cit.

[3] Lyon Médical, 1876.

The surface of the bones which are not altogether absorbed, is honey-combed with openings, from which pressure causes drops of blood or a red material to well up. The periosteum which covers them is very vascular, thick, and adherent; when it is detached, laminæ of bone are pulled off. The shell of bone which remains appears rugose, and is filled with holes which give it a spongy appearance.

The consistence of the bones varies with the degree of the disease. Sometimes they are as flexible as a wand, sometimes as soft as a bone which has been decalcified in acid, sometimes as soft as a muscle, or as a pulpy substance in which the finger can penetrate as in the tissue of the spleen, or of a hepatized lung. The knife always cuts them easily. But before they come to resemble rubber-tubes, the bones have remained a long time more or less resistant and elastic, though friable, it is true, and likely to break on the least strain. Kilian has advocated distinguishing two forms of osteomalacia: one characterized by friability of the bones (*Halisteresis fracturosa*, *psathyra*); the other characterized by softness (*Halisteresis flexibilis*, *absathyra cohærens*, *cerea*). Such a division cannot be accepted unless it applies to a predominance of the character of flexibility or fragility; for there are found at the same time, and in the same patient, bones which may be bent like a reed, without breaking, until they describe a half circle, and others which break like glass at the least touch, upon the patient's sneezing, or upon his changing his position in bed. Cases of *halisteresis* exclusively of the fracturing kind, appear to me to pertain more legitimately to atrophy or idiopathic fragility of the bones.[1]

The weight of the bones in osteomalacia diminishes simultaneously with their consistence. To what extent? The classical books do not say. Here are some figures taken from the paper of Langendorff and Mommsen. The cranium of the patient, which was at the occiput a centimetre (.39 inch) in thickness, weighed 370 grammes (8 lbs. Av.), including the lower jaw; while the normal cranium of a man weighs from 800 to 900 grammes (17.6–19.7 lbs. Av.). Of two equal pieces of the humerus, one from a patient with osteomalacia weighed 11.71 grammes (180 gr.); the other, taken from the body of a man of equal age who had died of acute tuberculosis, weighed 13.86 grammes (213 grs.); the mean difference was therefore 15.52 per cent. It cannot be objected, in regard to these weights, that the bone taken for comparison, from a phthisical patient, was ill chosen, because the bones of the phthisical are heavier. The increase in the density of the bones in phthisical patients, to which M. Charpy, director of the anatomical studies at Lyons, has given so much attention, is not constant on the one hand, and, on the other, is observed only in the chronic forms of phthisis.

The diminution of weight in osteomalacia is not constant. Bones may be found heavier in the first periods, and in certain slow forms of osteomalacia which do not pass beyond the first stage of the disease; for example, in cases analogous to those of Sir James Paget. Further, accoucheurs have noticed that some osteomalacic pelves are very light, whilst others are heavier than usual. Diminution or increase of weight depends upon the form or phase of the disease, at the moment of observation.

(2) *Deformities of the Skeleton.*—The constancy of these is such that they form an integral part of the symptoms of osteomalacia. A disorder which was absolutely free from them would not arouse a suspicion of the disease. Nevertheless, cases have been cited (Goodwin[2]) in which there were no deformities. It is not absolutely impossible that this may be the case in conditions where exceptional care is taken, and in a slight osteomalacia. But,

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[1] See page 967, *infra*.

[2] Archives Gén. de Médecine.

with a few exceptions, deformities are the rule. They result from two causes: flexibility of the bones and their fracture. The direction of the bone is changed because it bends, or because it breaks. I have already said that we usually find in the same patient bones which are bent, and bones which are broken. The deformities do not always appear in the same parts of the skeleton. Kilian has given as pathognomonic the onset in the pelvis. It has been objected to him that the lower limbs are first and most affected, as in rachitis. These contradictions disappear if, after the example of Volkmann, we distinguish two categories of osteomalacia, one *puerperal*, the other *non-puerperal.* In the first the attack begins in the pelvis, in the second in the limbs. The fact that the lower limbs are first affected does not always justify the assertion, in an absolute way, that the disease has begun in them. Deformities appear more readily in the lower limbs, because the erect attitude and walking impose greater efforts upon them than the upper limbs habitually put forth. Usually the upper limbs do not become deformed until the patient (whom pain, and the difficulty or impossibility of locomotion have for a long time interdicted from all laborious work) is confined to bed. In turning, he breaks his ribs or his clavicles; in raising himself on his arms, he breaks his humerus. Still, there are cases in which the first deformities from fracture have taken place in the clavicles. (Mondan.)

I have no difficulty, however, in admitting that the disease *seems* ordinarily to begin in the lower limbs, in the non-puerperal forms. Perhaps, indeed, this beginning is real; the greater vascularity, the greater stasis of blood in the lower limbs, and their usually greater work, might account for this priority. But the bones in osteomalacia are not deformed by bendings and fractures alone; they are deformed also by shortening upon themselves. When the long bones are completely softened, retaining only thin bony plates in the epiphyses or diaphyses, and resembling fibrous cylinders, the tonicity of the muscles alone may suffice to shorten the limbs by drawing the ends of the bones together, which in this way close up upon themselves like Venetian lanterns. This drawing up in the longitudinal axis, aided by flexions and fractures—which may also be produced by muscular action alone, without the assistance of the weight of the body or of any external violence—is accompanied by an increase in size, more apparent than real, in the transverse direction; an increase which may be made to disappear altogether by drawing upon the two ends of the bone, when its normal length will be restored. Very often there is a diminution, both apparent and real, in the size of the long bones as well as in that of the short bones. As an example of the latter, see the osteomalacic pelvis represented in Fig. 1454.[1]

Before passing the deformities in review, region by region, I ought to say yet a word about the *fractures.* They are complete or incomplete; much oftener incomplete than fractures in healthy bones. They are distinguished from the latter by the absence of laceration in the periosteum, which depends less upon the thickness of this membrane than upon the slight degree of consistence of the bone, and especially upon the moderate cause which produces them. In the flat bones fractures do not involve the whole thickness of the part, and there is no displacement. The number of fractures or bends which may be met with in an osteomalacic skeleton is unlimited. M. Buisson has counted seventy-six fractures in one patient, and even more may be found;[2] M. Buisson says that the seventy-six fractures were all more or less consolidated by callus or by osteophytes. This leads me to speak of the consolidation of these fractures. Usually at the autopsy there is seen at their seat no reparative effort beside thickening of the periosteum, formation of fibrocartilaginous material, or simply plastic exudation between the fragments. Bony consolidation is seen only in benign forms, or in the early stages. After having examined a large number of cases, it seems to me that Volkmann has perhaps exaggerated the truth in the following statement: "Whatever may be said, these fractures usually heal without difficulty by bony callus, as in healthy individuals."

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[1] See page 949, *infra.*

[2] Op. cit.

(*a*) *Bones of the Cranium and Face.*—The cranium may be rounded, or flattened laterally if the lateral decubitus is habitual. Usually it is but little deformed. Its sutures are effaced. The thickness of its walls is increased; in many cases it attains a thickness of from two to four lines (Souligoux),[1] one centimetre in the occipital region and seven millimetres in the temporal region (Mommsen and Langendorff), one centimetre and a half in the region of the parietal bones (Mondan),[2] 14 to 16 lines in the region of the parietals, that is to say, four times the normal thickness (Paget).[3]

The two tables are hardly distinguishable from the diploë, which is composed of spongy tissue with large meshes, filled with yellow marrow. The frontal sinuses have been found very much diminished in size, and the sphenoidal sinuses obliterated, the digital depressions being shallow, while the grooves for the branches of the middle meningeal artery were deepened. At the same time that they become thickened, the bones of the cranium become softened; they may be cut with the scissors or a knife. In the case of the Marquis Bernard d'Armagnac[4] they were said to be as soft as softened wax. The bones of the face are not always spared, they have been found thickened and softened, especially the lower jaw. Softening of this bone was present in different degrees in Souligoux's case, in which one part was soft, another spongy, another eburnated. All the teeth preserved their normal solidity—let us not forget that the patient was young.

It has been noticed that the lower jaw is constantly the last attacked. This is possible, because after this it would not be long before the patient died of starvation. The teeth it is said are usually not affected by the process, which would be explained by their different embryonic evolution. Nevertheless, Isenflam, Leblon, and Plenck, have found them also softened; Krause says that he has seen them cartilaginous. I believe that generally they cannot be found at all; for as the softened bones and gums fail to support them, they soon fall out.[5]

(*b*) *Vertebral Column.*—The spine is most commonly deformed by exaggeration of its normal curves. Cyphosis and cypho-scoliosis have been observed; but there may be the most unforeseen deviations, depending upon the degree of the softening and upon the parts of the column affected. The degree of shortening of the spinal column is proportioned to that of the abnormal flexions. It may be as great as thirty centimetres, which will be understood when the bodies of the vertebræ are seen reduced almost to their inter-vertebral disks. It is interesting to note that there has not yet been mentioned a diminution in the size of the vertebral canal, nor consequently any phenomenon of compression of the cord. Volkmann has seen the height reduced a foot and more in a few weeks, in consequence of diminution in the thickness of the bodies of the vertebræ, and of abnormal curvatures.

(*c*) *Clavicles.*—These bones break near their inner third, or are deformed by softening with exaggeration of their natural sigmoid curvature; the usual effect is to bring the shoulders together and to diminish the upper transverse diameter of the trunk.

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[1] Op. cit., p. 108.

[2] Loc. cit., p. 119.

[3] Loc. cit., p. 8, and Plate IV.

[4] Mercure, Mars, 1007.

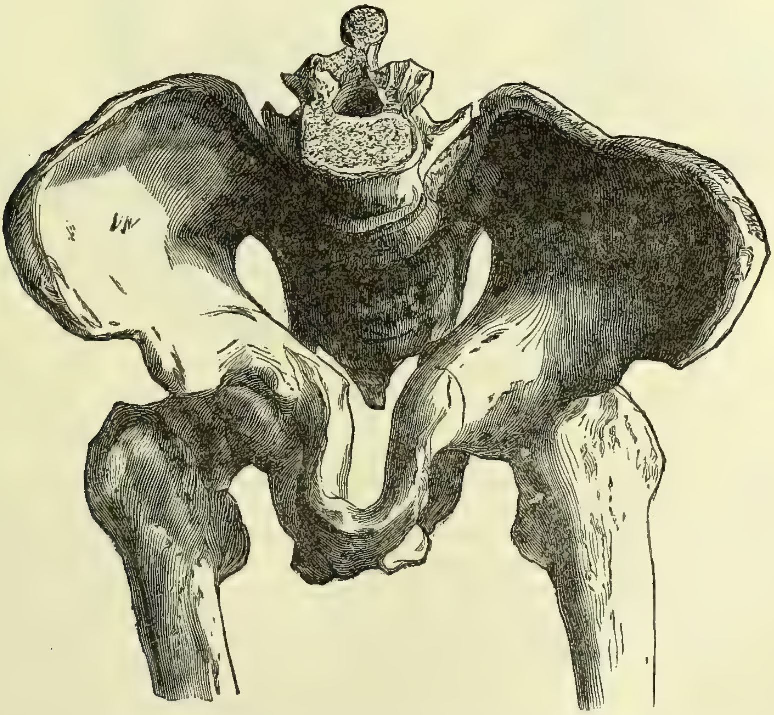
[5] See Gusserow, Ueber das Ausfallen der Zähnen bei Osteomalacie. (Monatblatt f. Geb., Bd. xxiii.)

(*d*) *Ribs and Sternum, Thorax.*—The sternum and the ribs are the seat of a greater number of fractures than the other bones. The non-consolidation of these fractures, together with softening, causes the thorax to have, so to speak, no regular form; it takes that which is imposed upon it by position and by gravitation, as if the viscera were shut up in a cloth bag. When the patient is lying down upon his back, the transverse diameter is increased; the thorax is flattened, the belly spreads out, and this effect is the more manifest because the trunk is shortened and crowded together, in consequence of the sinking down and deviations of the spinal column. When the patient lies upon his flanks, the antero-posterior diameter is the longer, and the sternum makes a very marked prominence in front, so that the appearance of the thorax recalls the conformation of a pigeon's breast, to which the breast of the osteomalacic is commonly compared.

(*e*) *Scapulæ.*—The scapulæ are drawn forward by the shortening of the clavicles, they are separated behind, and become prominent; for which reason they are called "winged." They are twisted around the thorax by the action of the muscles, and so present a greater depression in front.

(*f*) *Pelvis.*—This presents the most typical deformities, according to Volkmann; they at least attract the most attention from accoucheurs, who are particularly interested in the recognition of osteomalacia. According to M. Charpentier,[1] the following are the characteristics of the osteomalacic pelvis (see Fig. 1454): "The wings of the ilium, which are sometimes small and

Fig. 1454.



Pelvis, osteomalacic to the highest degree. The woman succumbed to the progress of the disease. (Stoltz's collection.)

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[1] Traité d'accouchements. Paris, 1883.

transparent, and have usually lost their shape and their normal thickness, bend, are curved upon themselves like a horn, and have a groove, a fossa, which is directed from above downwards, and which is ordinarily single, though sometimes bifurcated. The cotyloid cavities are pressed back by the femurs, and are pushed upwards, forwards, and inwards, thus approaching one another and the promontory of the sacrum. The horizontal rami of the pubic bones approach each other and become almost parallel, leaving between them a single narrow interval at the upper part, which is not much larger below where the ascending rami of the ischia and the descending rami of the pubic bones have undergone the same change of position, giving the symphysis the shape of a sort of duck's bill protruding in front of the pelvic ring. The pubic arch thus disappears, and is replaced by a kind of deep and narrow fissure into which the finger penetrates with difficulty."

The tuberosities of the ischia are forced far inwards; the sacrum is, as it were, doubled upon itself in the vertical and transverse directions; the lumbar part of the spinal column, in consequence of the descent of the promontory, forms a prominence which in its turn narrows the superior strait. "Thus doubled up and pushed in upon itself, the pelvis presents a strange appearance, which has led to its being compared to a three-cornered hat." Every part is affected by the deformity—the superior strait, the inferior strait, the cavity—and often in such proportions that the diameters are reduced to an unimaginable narrowness. As Depaul has well said, the pelvis has a *rumpled* appearance.

It is not necessary for a woman to remain upright or seated in order that the osteomalacic pelvis shall assume these characteristics. The lateral decubitus, alternating from one side to the other, produces an effect analogous to that of the upright position, by pushing in the trochanters. Nor is it in women only that the pelvis is deformed; it becomes deformed also in men; but only in women has osteomalacia been seen to be localized in the bony pelvis.

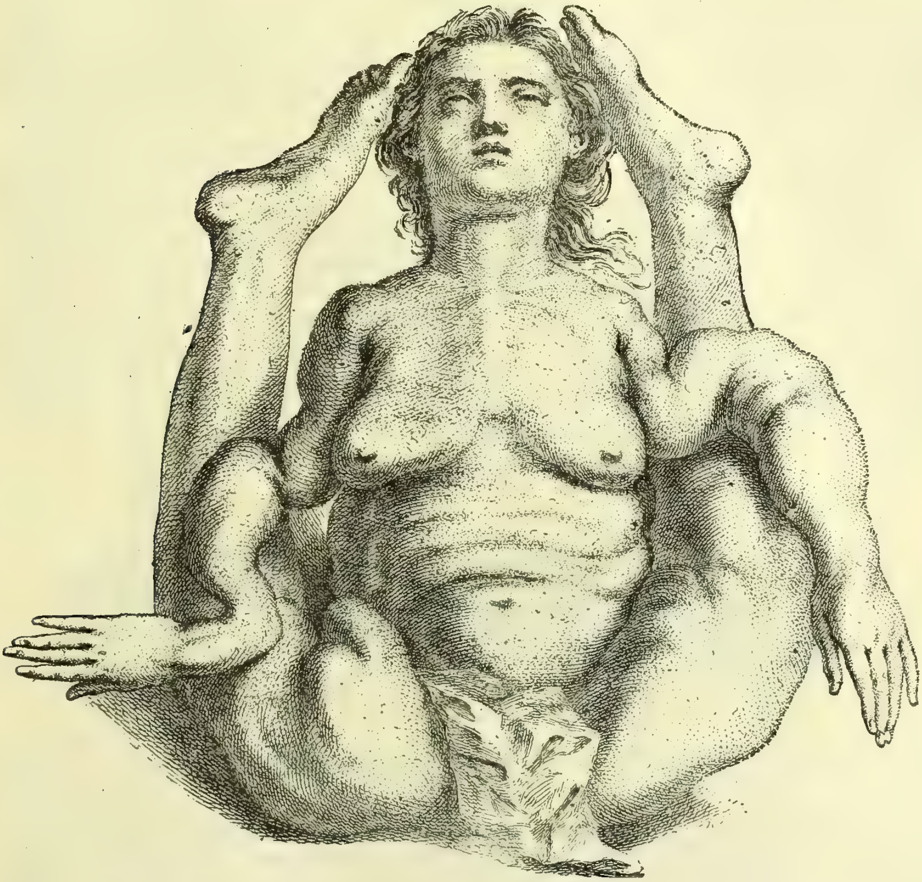
(*g*) *Upper Limbs.*—The humerus is curved forwards by the action of the deltoid; in some cases it has taken the shape of the letter Z, in others that of S; fractures and flexions combine to bring about such deformities. The bones of the forearm are more rarely deformed. The bones of the hand have been seen to be spongy and fragile; but I do not find a deformity of the end of the fingers reported except in the case of Czerny, published by Landgendorff and Mommsen; the ungual phalanges were club-shaped, and the nails were three times as broad as they were long.

(*h*) *Bones of the Lower Limbs.*—Like the other bones, these are deformed by exaggeration of their normal curves; the femur curves forwards and outwards, the tibia becomes twisted and also curves forwards, the feet are extended by pressure of the bedclothes, and are shortened. To these deformities, due to softening and weakness of the bones, are joined those which result from fractures, to which the lower are more exposed than the upper limbs. So many influences may affect these deformities that they actually baffle description. As an example of an extreme type, I reproduce (Fig. 1455), a picture of the *femme Supiot*, from the drawing of Morand *fils*, a glance at which will tell more than a description which would always be incomplete in spite of its length, because it could not include all the features of all the isolated cases.

2. *Structure.*—Bones affected with osteomalacia present on section an appearance which varies according to the degree of the affection. At the beginning their structure appears but little altered, but afterwards the spongy portions rarefy progressively, and the compact portions become filled with alveoli. The enlarged spaces of the spongy tissue of the bone lose their normal medulla,

and little by little are filled with a sanious or reddish, sometimes colorless, liquid, "showing all degrees of ecchymosis, sometimes gelatinous and even

Fig. 1455.



La femme Supiot. (Fac-simile of the drawing of Morand in the Mém. de l'Académie des Sciences, t. xxii. 1753.)

pulpy. The medullary canal is in some cases obliterated by the separation of the fibres."[1] Figure 1461[2] represents a section of a femur from a case of *osteitis deformans*, of Paget. Is this not exactly what has been described here by Nélaton in speaking of osteomalacia? We cannot discuss this mode of filling up of the medullary canal, or affirm whether it is obliterated by tissue of new formation, or by separation of the lamellæ of the compact tissue by interstitial medullization. However this may be, if what Nélaton describes may be met with in the beginning, it is certain that, in the last stages of the disease, the medullary canal enlarges enormously, that all the bone-substance sometimes disappears, and that "there remains of the bone nothing but a sort of thin external pellicle, analogous to the shell of an egg." (Nélaton.) The mass contained in the osteo-membranous sac which replaces the bone in the last stages, resembles a dregs-of-wine-colored jelly more than marrow; it is a sort of fleshy parenchymatous substance which recalls to the observer the tissue of the liver, of the gums, of the brain-pulp, of the pulp of the spleen, etc. This diffluent material usually has scattered through it cysts, which may have a diameter of an inch, inclosing a sanious, yellow, oily, serous, sometimes even purulent liquid, "which gives the tissue the appearance of Holland cheese." (Souligoux's case.[1])

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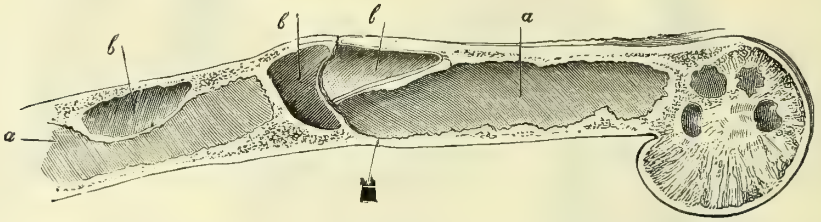
[1] Nélaton, op. cit., p. 634.

[2] See page 964, *infra*.

Cruveilhier thought that these cavities resulted from dilatation of the veins. But it cannot be so, because injections driven into the veins do not reach these cysts. It is more probable that they owe their origin to hemorrhages more or less completely absorbed. They are lined with a smooth white membrane in which no vessels can be discovered. The periosteum may itself be found to be infiltrated with a sanguinolent material; the joints usually remain unaffected, the cartilages likewise. Yet a number of observers say that they have seen them softened. Perhaps compression and immobilization were the true causes of this. The flesh which surrounds the diseased bones is œdematous and flabby; the muscles pale, anæmic, atrophied, stretched or retracted, according to the deformity of the limbs. As for the viscera—the lungs, heart, spleen, liver, kidney, etc.—they present, as far as the osteomalacia is concerned, only secondary alterations, resulting from the mechanical interference with their functions induced by the sinking in of the portions of the skeleton which protect them. In some cases absence of cadaveric rigidity has been noticed. In a large number the account of the necropsy mentions the presence of calculi in the kidneys or bladder.

Fig. 1456.



Section of osteomalacic humerus (left). *a*, enlarged medullary canal; *b*, *b*, *b*, cysts or spaces of the medullary canal; *c*, *c*, line of fracture dividing one of these cysts. (Mommsen, Pl. XVIII.)

Our knowledge of the minute alterations of the bone-tissue in osteomalacia is due especially to the labors of Virchow, Volkmann, Winckel, Schieck, Weber, Rokitansky, Rindfleisch, and Cornil and Ranvier. The following is the account given by the latter:[2] "In the first stage of alteration the bones have preserved their size and do not exhibit any rarefaction; nevertheless they may be divided with a cutting instrument. At this stage, it may be observed in histological preparations, that the centres of the osseous trabeculæ still contain calcareous salts, whilst their borders are completely devoid of them. Only the latter parts are colored by carmine, according to Rindfleisch. It is indeed known that undecalcified bones do not take up carmine. The bone-corpuscles are such as are found in preparations of bones decalcified in chromic or hydrochloric acid. The vessels of the medulla are filled with blood. The fat-cells are less numerous than usual, and in their place there are developed round or irregular cells, sometimes fusiform or flattened. Soon the medulla is the seat of diffuse hemorrhages, which are seen in the form of ecchymotic stains or patches. Hemorrhages may also occur under the periosteum, which is now only slightly adherent to the subjacent bone-tissue. In the second stage, the bones become considerably deformed. In this second stage the bone-trabeculæ are not only decalcified throughout, but even in large part absorbed. The enlarged medullary spaces are filled with fœtal medulla, which has the appearance of the splenic pulp. There is also found constantly in the medullary cells, coloring matter, in the form of yellow or brown pigment. This pigmentation of the cells is caused by the extravasations of blood which have been already mentioned."

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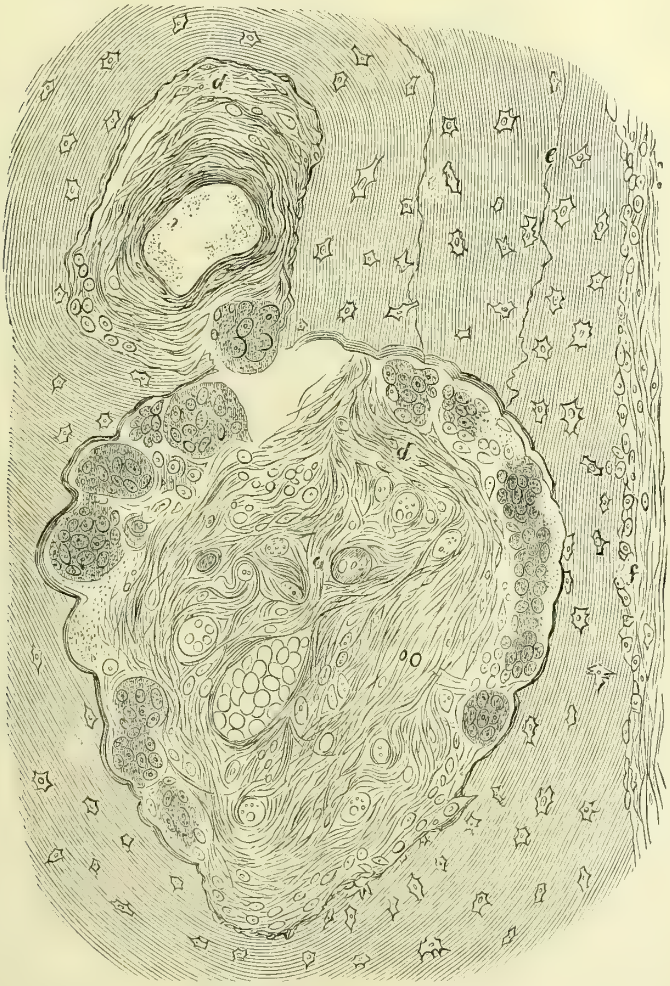
[1] Souligoux, op. cit., p. 113.

[2] Traité d'Histologie Pathologique, t. i. p. 387.

In Fig. 1457 I give a histological section. In it will be noticed the enlargement of the Haversian canals, the semilunar scalloping of their edges, which are eroded as in osteitis. The Germans lay great stress upon the presence of multinuclear cells (the *osteoclasts* of Kölliker, of Wegner, of Rokitansky, and of others; the *myéloplaxes* of Robin) in the so-called lacunæ of Howship. Kölliker, Wegner, and Langendorff and Mommsen, have seen particles of lime in these cells, whence their idea of attributing to the giant-cells an active part in osteomalacia. Further, it is to them that they attri-

Fig. 1457.



Section of osteomalacic humerus, decalcified with dilute nitric acid. (Hartnack, Syst. vii. oc. 3.) *a*, *a*, enlarged Haversian canals, with vessels in section; *b*, slightly altered bone-substance; *c*, lacunæ of Howship with small cells; *d*, fusiform elements; *e*, lines uniting indistinct lamellar systems; *f*, periosteum. (Fig. 6, Czerny's case, in Langendorff and Mommsen's Memoir.)

bute all the phenomena of absorption of which bone-tissue may be the theatre.[1] It is interesting to note that Durham, Langendorff and Mommsen, and others, have noticed points of sclerosis in osteomalacic bones (Fig. 1456).

It is generally recognized that the bone-corpuscles have no vital activity and act like inert bodies. J. Busch went so far as to believe that the osteoblast changed into an osteoclast in order to destroy its own work, like Penelope. Here are hypotheses enough; histology has still much to do. The only points yet gained are that decalcification starts in the Haversian canals and extends progressively to the whole system of lamellæ of which these are the centres; that their edges are eroded as in ordinary osteitis; and that the medulla increases in quantity and reverts to the fœtal condition.

3. *Chemical Analysis of the Bones.*—All analyses (Becquerel, Davy, Rostock, Rees and Buisson, Marchand, Schmidt, O. Weber, Langendorff and Mommsen, etc.) have furnished this uniform result, to wit, that the calcareous constituents are diminished in proportions which are always considerable, and which vary with the degree of the osteomalacia. The diminution of the earthy parts affects especially the phosphate of lime. According to Davy, the organic constituents bear to the calcareous the proportion of 74 to 26; according to Rostock of 79 to 20. Rees has investigated this proportion in the majority of the bones separately. I shall not reproduce more figures here, because figures cannot give any positive idea, on account of the varying degrees of softening in the bones examined by different chemists.

It has been long known that osteomalacic bones are fat; they are oily, says Buisson. When exposed to the air, considerable quantities of fatty matter exude from their pores. I have at this moment a beautiful example of this under my eyes. It might be thought to be a specimen of gouty osteophytes. Mommsen, after having treated them with ether, found fat in the bones of Czerny's patient in the proportion of 60.38 to 100 parts, instead of 24.31, which is the normal figure.

The augmentation of the fat which takes the place of the bone-tissue is therefore enormous. But these figures must not be made a basis of generalization; they are exact only for the special cases which furnished them. The same observer, and in the same case, found, by calcination, in 100 parts of the ashes of normal bone, lime = 53.05; phosphoric acid = 43.98; and in 100 parts of the ash of an osteomalacic bone, lime = 44.48; phosphoric acid = 34.76. In bones which are much altered there is no longer any trace of glutine or chondrine found. Sometimes the marrow is acid, sometimes it is alkaline or neutral; this depends on the presence or absence of the abnormal acid (lactic) of which I shall soon speak.

Among the abnormal substances which chemical analysis has discovered, I will call to mind the opaque albuminous bodies of Bence-Jones, found in the medulla by Virchow;[2] and lactic acid, the presence of which has been observed by Marchand and by C. Schmidt.[3] O. Weber,[4] Mœrs and Muck,[5] and Mommsen[6] have not found either the deutoxydhydrate of albumen (identical with the tritoxyproteine of Mulder) or lactic acid.

Symptomatology of Osteomalacia.—Whatever may be the form of osteomalacia, the symptoms which accompany it depend either directly upon the nature of the affection, or secondarily on disturbances of the functions of different organs. The onset is always marked by more or less acute pains, which are increased at night by the warmth of the bed, and which last while the process is advancing. Movement and pressure make them more acute. Before the appearance of the deformities due to breaking or bending, they are almost always attributed to rheumatism, which they simulate. The seat of pain varies, naturally, according to the bones affected. In puerperal osteomalacia, that which is observed in women who have borne children, generally in large number, the pains almost always begin in the pelvis. One or both of the ischiatic tuberosities become painful; thence the pain travels to the symphysis, and to the spine of the ischium, then to the other bones of the pelvis, the sacrum, and the lower lumbar vertebræ. Very often the coxo-femoral joints become painful; then motion of the thighs is difficult; walking is impeded, if it is still possible; in women, inability to abduct the thighs is characteristic. (Volkmann.) The shoulders are attacked in turn, and finally the limbs, the thorax, and the head share in the general affection. Locomotion, from being painful, becomes impossible; sitting down soon becomes too much for the strength of the patients, who, in order to avoid the pain caused by movement of the joints and bones, and by fatigue, condemn themselves to as complete immobility as possible. Finally, they are confined to bed, where they enjoy only comparative repose. The sensitiveness of the ischia, and of the sacral and lumbar vertebræ, does not permit them to remain long seated or lying upon the back; they lie sometimes on one side, sometimes on the other, finding no position comfortable. At the end they are seen to assume the most strange positions. Doubled up upon themselves, reduced in length by the shortening of the spinal column and limbs, they come to be only shapeless and whining masses of flesh. The poor creatures suffer continuously, and cannot move to supply any need without the help of others, and without risk of breaking some of their bones.

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[1] E. Vincent, De quelques travaux récents sur le système osseux (Revue Mensuelle de Médecine et de Chirurgie, 1880).

[2] Virchow, Archiv, 1852.

[3] Ann. d. Chemie, Bd. lxi.

[4] Weber, Archiv, Bd. xxxiv.

[5] Deutch. Arch. f. klin. Med., Bd. v.

[6] Mommsen, loc. cit.

I have described above the deformities of the skeleton. "It has been said that the pains subside from the moment when the curvatures occur, but this phenomenon is far from being constant." (Nélaton.) Besides, when the pains which depend upon progressive osteomyelitis or fracture disappear, the deformities of the trunk and limbs are the cause of much discomfort and suffering, dependent upon functional disturbances of the viscera—the lungs, heart, stomach, digestive canal, etc. M. Gusserow mentions, as characteristic of the disease, the sulky and morose physiognomy of women. It will be admitted that they have little cause to be smiling. As an evidence of the nervous irritability of these patients, Lobstein mentions a woman whom it put in a bad humor to see a cambric handkerchief waved before her, while at the same time it brought on a fit of pains in all her limbs.

In *non-puerperal* cases, osteomalacia usually starts in the vertebral column and the thorax, according to Volkmann. The bones of the pelvis may sometimes remain entirely free, or at least so little changed that they are not deformed. The disease shows a peculiar disposition to extend to the greater part of the skeleton, to the limbs, and even to the cranium. It has been said that the cranium is rarely affected. In the majority of recent observations the walls of this cavity have been found much thickened, even in the *osteitis deformans* of Paget. (See pp. 963, 964.) The puerperal form is relatively more frequently limited to the pelvis and to the lower segment of the vertebral column. Consequently, the progressive non-puerperal form may, in a general way, be considered the more grave. (Volkmann.) This may be only because women do not live long enough to go through the entire evolution of the disease. A large number succumb to the complications of pregnancy and child-birth, or to the operative measures undertaken to deliver them at the time of parturition. Nevertheless, the cases in which delivery has been accomplished, either by the efforts of nature alone or by the assistance of art, are not extraordinarily rare. Osteomalacia demands Cæsarean section less frequently than one would believe. The great softness of the pelvis lends itself to the spontaneous or assisted passage of the fœtal head. Kilian, Robert, Schmitz, Hugenberger, Olshausen, Kezmarsky, Breslau, Fasbender, Pullen, Krassowsky, Winckel, Schieck, Weber, and Ebenhoff have found, during life and in the cadaver, pelves so distensible as to be expanded by the fœtal head like India-rubber, to which Schieck has given the name *Gummi-Becken*, India-rubber pelves or elastic pelves.

In both forms, puerperal and non-puerperal, when osteomalacia passes through its extreme stages, the most varied functional disturbances are seen to be added to the disorders already mentioned in connection with the locomotor apparatus.

Dyspnœa comes on and increases, as well as bronchitis and congestion of the lungs. The circulation becomes more and more disturbed, in proportion as the deformities of the trunk increase the interference with the functions of the lungs, of the heart, and of the large vessels. In the *femme Schœff*, the arch of the aorta had a double curve (Th. Drouineau).

The imperfect supply of blood, the anæmia due to confinement to bed and to insufficient assimilation, and the mechanical obstacles to the return of the blood, cause œdema of the limbs, and of the dependent parts, and render the patients dropsical. (Volkmann.) The digestive functions are disturbed also, for the same reasons which lead to anæmia and cachectic œdema. The patients often have diarrhœa and vomiting towards the end; cachectic fever comes on, and after a variable time—generally a long one—after having been better and worse intermittently, the patients succumb in a state of marasmus. Sometimes thrombosis ends the scene suddenly. In the last stages of the disease there are often profuse sweats. I have already spoken of the effect of softening of the lower jaw, which renders mastication impossible, and so hastens death; that is, of course, provided that the patient is not nourished with liquid food, and, if necessary, by the œsophageal tube and with nutritious enemata. The Marquise d'Armagnac lived a long time on liquids. Dujet reports that he saw a squirrel die of starvation, being affected with osteomalacia and unable to crack its food.

The *intelligence* ordinarily remains unaffected in the midst of this decadence of the organism, in spite even of the participation of the cranium in the disease. Yet there are cases in which the subjects have shown some imbecility or dementia towards the end. Such, for example, was Czerny's case. At the autopsy, both hemispheres of the brain were found to be hyperæmic, with superficial ecchymoses, enlargement of the ventricles, etc. Finkelburg[1] saw two cases of osteomalacia, following parturition, in which the patients were attacked with melancholy, and afterwards with incurable mania, with a predominance of hallucinations of hearing. It was thought that these psychical disturbances were caused by compression of the brain by the basilar process of the occipital bone, which was pressed up against the brain in consequence of the softening of the neighboring bones.

I have not spoken yet of the *state of the urine*, which has a certain position in the clinical picture of this disease. Since the phosphates are lessened in the bones, they must be eliminated from the organism, or take refuge somewhere (accidental calcifications, renal and vesical calculi). The most natural route of elimination being that of the urine, it is not astonishing that this excrementitial liquid often contains an excess of phosphates. Litzmann has also found in it an excess of carbonates. Billroth says that the phosphates which pass into the blood are eliminated from it in great part in the form of oxalate of lime. Other equally conscientious observers have arrived at opposite results. Schützenberger, Mœrs and Muck, and Volkmann, have not found any increase in the phosphates. Pagenstecher even found a diminution of the earthy salts in cases which progressed rapidly. Langendorff and Mommsen also have seen a considerable diminution of the phosphates. These differences may be explained in two different ways. Phosphates have not been found in excess in the urine, because the examination was made during a period of calm. They have been found diminished, because, the work of decalcification being ended, there was no or scarcely any bone left; and because, being deprived of this source of supply, the combustion of the organism would necessarily be characterized by a lessened phosphatic waste. The other explanation would be to say that the earthy salts were eliminated by other secretions or excretions than the urine; by the sweat, by the tears, or by the saliva. It has indeed been observed in some cases that these liquids, when allowed to stand, deposited a white sediment like that of the urine. In nursing women, might not the milk also be an important route of elimination? Pagenstecher did not find, it is true, any excess of phosphates in the milk, but he did not find it anywhere in his patients. This is a point to be verified, like so many others, in this difficult and complex subject of osteomalacia. Pagenstecher believes that the principal route of elimination is the bronchial and intestinal mucous membranes; and that thence arise the pulmonary catarrh, the digestive disorders, and the diarrhœa which are almost constant in this disease. It would be well in future to analyze the urine, and all the excretions and secretions from the beginning to the end. The great difficulty would be to establish a diagnosis soon enough. However it may be in regard to the constancy and degree of elimination of phosphates by the urine, there have been observed in several cases phosphatic deposits in this fluid, renal gravel, and calculi in the bladder.

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[1] Osteomal. mit Irrensein (Allg. Zeit. f. Psychiatrie, Bd. xviii.).

Among the abnormal substances in the urine, chemical analysis has also revealed a substance which its finders have called deutoxydhydrate of albumen. (Prout and Bence-Jones.)[1] Mommsen has thrice found the ordinary reaction with albumen, and at other times the reaction attributed to the deutoxydhydrate.[2] The presence of albumen might be due solely to a calculous nephritis. More important in the interpretation of osteomalacia is the presence of lactic acid in the urine. It was first noted by Mœrs and Muck,[3] according to Mommsen. Its quantity varies with the severity of the disease. Mommsen found lactic acid in treating the urine of the patient of Czerny by the method of Hoppe-Seyler (whiting, alcohol, sulphuric acid, ether, oxide of zinc). But what somewhat impairs the value of these observations is the fact that normal urine sometimes contains lactic acid. (Lehmann, Brucke, Mommsen.[4]) Brucke believes even that to this substance should be partly attributed the acid reaction of normal urine.

Etiology and Nature of Osteomalacia.—The etiology and nature of osteomalacia are full of obscurity. There are distinguished three orders of causes:—

1. *Predisposing Causes.* (1) *Age.*—It is said to be rarely observed below twenty years. Nélaton says that the cases of osteomalacia which are believed to have been seen in the new-born were very probably only cases of rachitis. Nevertheless, if by the term osteomalacia is understood the softening of already existing portions of bone, the possibility of its occurrence even in the new-born and in children, must be admitted. I have under observation at the present time, at La Charité, in a little girl twenty-one months old, a case of softening of the diaphyses of both femora and of both humeri, which

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[1] Lancet, 1847.

[2] Mommsen, loc. cit., p. 14.

[3] Deutsch. Arch. f. klin. Med., Bd. v.

[4] Mommsen, loc. cit., p. 16.

I can attribute only to osteomalacia. Dr. Rehn, of Frankfort, made at the fifty-fifth reunion of the *Curiosi Naturæ*, a communication on infantile osteomalacia.[1] Recklinghausen and Rehn have seen several of these cases. From the microscopical point of view, the bones present the same changes as those of adults; the osseous trabeculæ are almost entirely deprived of calcareous salts. In the epiphyses there is an extremely slight rachitic condition. The most remarkable fact is the extreme softness of the bones. Macroscopically and clinically, infantile osteomalacia is characterized by slenderness of the skeleton, the abnormal flexibility of the long bones coinciding with absence or insignificance of the epiphyseal enlargement, which is scarcely perceptible on the ribs. The bones of the legs, thighs, forearms, and arms, and the ribs, show curvatures. When the bones are touched or the children are made to walk, unquestionable manifestations of pain are provoked. Examination of the urine does not disclose anything noteworthy. It is important to observe that all the children traced or examined by Recklinghausen and Rehn, were of the female sex and in their second year. The prognosis is better than in adults. Good nourishment, preparations of iron and of the phosphates, and cod-liver oil, have enabled M. Rehn to save three patients out of four. It cannot be objected, with M. Fleisch, that these were simple cases of rachitis. The histological examination made by Recklinghausen having disclosed the decalcification peculiar to osteomalacia, and the cases followed by recovery having presented the same set of symptoms (except death) as those which ended fatally, it seems to me that we are not authorized to reject the diagnosis of infantile osteomalacia without further ceremony. Physicians and surgeons who devote themselves to diseases of children ought in future to give their atttention to this point.

(2) *Sex.*—Statistics show a notably greater frequency in the female sex. The proportion of 13 females to 3 males has been found by Gaspari; of 20 to 1, by Marjolin; of 36 to 11, by Beylard; of 4 to 1, by Drouineau; of 10 to 3, by Nélaton. In women it is ordinarily after a number of confinements that the disease manifests itself. According to Kilian, no less than five confinements are necessary to give rise to the disease in women predisposed to it, but observation has since shown that sometimes a single pregnancy suffices to give rise to osteomalacia, even in its gravest form. According to all observers, pregnancy is, of all known causes, that of which the influence is the most potent and the most incontestable. Of 36 women affected with this mysterious disease, Drouineau found 15 who had had children, and he noticed that those who were primiparæ had not become pregnant until about thirty years of age.

(3) *Climate.*—Osteomalacia has been seen in all latitudes. It is very rare in England, according to Curling; quite common on the shores of the Rhine and in the valleys associated with the basin of that river, according to Volkmann. It is often observed in Bavaria, in northern Italy, and in Flanders. In Norway, according to Prosch, the plant called *Herba ossifraga* has the property of softening the bones of animals which eat it. They can be cured by mixing calcined bone-dust with their food.

(4) *Heredity.*—There are very few facts to show the influence of this upon osteomalacia. The observation of Eckmann[2] is always cited. This author reports that in a family which lived among the iron mines of Danemora, in Upland, there could be counted three generations, the different members of which were attacked, after puberty, with softening, fragility, and distortion of the bones. No one in this family had been affected with vene-

[1] Ueber Osteom. im Kinderalter (Berlin. klin. Woch., S. 706. 1882).

[2] Dissert. med. desc. et casus aliquot osteomalaciæ sistens. Upsal, 1788.

real disease. They did not live in a marshy country; their food was similar to that of the other miners. The first member of this family of deformities, Nicholas Ecroth, who is said to have died rachitic, had healthy parents who had worked in the same mines.

2. *Hygienic Causes.*—As osteomalacia is more rarely seen among the rich than among the poor, it has been concluded that poor food and poor hygienic conditions contribute to produce it. Everything which weakens the organism, everything which impairs its nutrition, favors the occurrence of the disease; bad food, hard work, privations of all sorts, damp and ill-ventilated dwellings.

3. *Pathological Causes.*—Does rheumatism prepare the way for osteomalacia? It is more probable that the pains belonging to osteomalacia have been confounded with those of rheumatism. All cachexias have been looked upon as predisposing causes: syphilis, scurvy, diabetes, cancer, etc. The disease has also been attributed to onanism, to the abuse of mercury, to metastasis, etc.

4. *Proximate Cause.*—This is still unknown, although many hypotheses have been put forth in regard to the essential, proximate cause of osteomalacia. Let us see what they are worth. Hérissant, having softened bones in the oily fluid from carious bones of syphilitic or scorbutic patients, concluded that osteomalacia was due to the presence of a rancid and putrefied oil. Navier[1] expressed the idea (it is old, we see) that the bones must be softened by an acid. Renard[2] spoke of the excess of phosphoric acid, an hypothesis which has been revived in our days. Stanski says that the presence of this acid in the body has not been demonstrated, and asks whether, in addition to the disappearance of the lime-salts, there is not a change of structure and a degeneration of the bone-tissue, and, like Gaspari, he refers the softening to an inflammation; in support of which opinion he mentions the violent pains, the general heat, the swelling and easy separation of the periosteum, and the liquefaction of the hyperæmic medulla. Eckmann[3] supposes an innate feebleness of the digestive organs which does not permit the nourishment of the bones. Morand, the younger, believes that the bony juices do not reach the bones and escape by the urine, and he cites as an evidence the white deposit which forms in this liquid, and the presence of stones in the bladder. Pravaz,[4] rightly supposing the presence of lymphatics in the bones, says that by exaggerated activity they take up too much of the calcareous material. This is a rational hypothesis, but there is nothing to prove it. Drouineau recognizes the inflammatory nature of osteomalacia. It is an osteitis which simply has some peculiar features. Rindfleisch regards osteomalacia as resulting from venous hyperæmia or premature senility of the bones. He has shown that the bone-tissue resembles that from which the lime has been removed by hydrochloric acid, and that the liquefaction proceeds from within outwards in the Haversian canals, making reëntrant angles, lacunæ of Howship, "such as are seen in the line of absorption in inflammations, in caries, etc." He recognizes a passive hyperæmia going on to stasis. "I could even understand," he says, "that the blood retained in the marrow of the bone might produce there a greater quantity of carbonic acid, and that this acid would serve to dissolve the lime salts." But this, says Ranvier, "is only an ingenious notion."

We have seen that Marchand, Schmidt, and Weber had several times detected the presence of lactic acid or lactate of lime in osteomalacic bones. Hence the hypothesis of the morbid production of lactic acid as the etiological basis of the process. But it remained still to know why this acid was in excess.

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[1] Observ. sur le ramollissement des os. Paris, 1755.

[2] Ramoll. remarq. des os d'une femme. 1804.

[3] Loc. cit.

[4] Déviation de la colonne vertébrale.

This hypothesis has received considerable support from experimentation. Heitzmann has made herbivorous and carnivorous animals ingest lactic acid. The following are his conclusions: "The result of my experiments on the continued administration of lactic acid, is that, in carnivora, there are artificially produced, at first, rachitis, and afterwards osteomalacia; whilst in herbivora osteomalacia is seen to occur without the symptoms of rachitis having preceded it. Lactic acid, in contact with the osteogenic regions, or with completely developed bone, manifests its great affinity for lime, and succeeds either in preventing the formation of bone (rachitis), or in dissolving the bone already formed (osteomalacia)."

Experiments on animals and clinical observations are still needed in order to be certain in regard to the part of lactic acid in osteomalacia. Is it cause, or is it effect? This is the question for it as for the microbes in so many diseases, tuberculosis among others.

Diagnosis of Osteomalacia.—This can be deduced naturally from what has already been said, and from what I shall add about the osteitis deformans of Paget (which I call benign hypertrophic osteomalacia), about the pseudomalacia of young bones or of bones medullized by inflammation, about atrophy of bones (senile and fatty osteoporosis), and about idiopathic fragility of bones. I will only speak here of the differential diagnosis from some diseases with which osteomalacia has been confounded, and which I have not described.

(1) *Rheumatism* is hard to distinguish from osteomalacia at the beginning. There are the same intermittent, shifting pains. But by paying some attention to them, it will be noticed that in rheumatism the pains are less acute, and that they commence rather in the joints, or in the muscular masses, and not deep in the course of the bones. In rheumatism the urine contains urates in excess, in osteomalacia it often deposits phosphates.

(2) *Syphilis* can give rise only to osteitis and periostitis which deform the bone by hyperostosis or by fracture (bone-gumma). Curvature from simple syphilitic softening is rare, if indeed it has ever been seen. The history and course of the disease will dissipate any doubts which may exist at the first examination.

(3) *Myelitis* could only lead to hesitation in case of osteomalacia beginning in the spinal column; but in myelitis, spinal pains, yielding, and curvature of the column, are not the dominant symptoms. There may be weakness in the lower limbs, lightning-pains, formication, and cutaneous anæsthesia. If there be locomotor ataxia, the gait will be abrupt and irregular, and not tottering as in osteomalacia affecting the lower limbs. Finally, there is neither deformity of the limbs by bending or by fracture, nor diminution of the stature.

(4) The *nervous osteopathies* also are not characterized by bending of the long bones; the articular extremities undergo a process of wasting, which deforms them and causes them more or less to disappear, being sometimes accompanied by colossal hydrarthrosis (of which I have seen one case, in the knee, in a neurotic patient with the morphia habit), and it gives rise to deformities which are distinguished from those of osteomalacia by being situated in the joints.

(5) *Pott's disease* has been confounded with osteomalacia through errors of belief rather than of clinical observation. Thus Piorry and Souligoux place caries of the vertebræ with bone-softening, alongside of true osteomalacia. The deformities of the spinal column in Pott's disease are distinguished from the rounded curvatures of osteomalacia by their angular shape, and by the ossifluent abscesses which often accompany them.

(6) *Cancer* of the vertebræ merits more attention. In certain diffuse forms of cancer, the symptomatic picture may be altogether like that of osteo-

malacia. (Volkmann.) But it is very rare for the diffusion of the neoplasm not to have been preceded by a carcinomatous tumor in some organ—the breast, the uterus, etc.—or circumscribed in some part of the skeleton.

I have so often, in the course of this article, indicated the differences between *rachitis* and osteomalacia, that it would be a useless repetition to recur to them here.

Professor Lücke, of Strasbourg, has recently proposed percussion of the bones as a means of diagnosis between caries and necrosis. It may be seen from Piorry's *Traité du plessimétrisme*, and from the monograph on softening of the bones by Souligoux, his pupil (1866), that the Professor of Clinical Medicine in Paris taught that all diseases of the bones—fractures, luxations, atrophy, hypertrophy, tumors, etc.—could be diagnosticated and marked out by means of mediate percussion. I refer the reader, for further particulars, to the writings of this author and his pupils, restricting myself to saying that Piorry assigns a *malacic sound*, dull, not ringing, to bones affected with the disease which we are studying. Happily there are other means besides percussion for diagnosticating diseases of the bones.

Prognosis and Course of Osteomalacia.—Always sad, says Volkmann, and all the more sad because death, which is almost always the end of this terrible malady, usually lingers long. In women, as we have seen, a first pregnancy may bring on the most serious developments of osteomalacia. But usually this is not the case, a first confinement awakening only moderate ischiatic and sacro-lumbar pains, which hardly lead to the suspicion of osteomalacia. Then, when the lying-in is over, there is a remission, even an apparently complete recovery. As the disease does not interfere with any function—neither menstruation, fecundation, nor gestation—the woman remains apt for conception. If new pregnancies occur, the disease returns with each, increasing in severity from pregnancy to pregnancy, and thus progressively reaching its height. The history of the *femme Supiot* is a classical example of this advancing course under the influence of the puerperal state. The cases in which, on the contrary, the disease ameliorates during a new pregnancy, are excessively rare; but they are undeniable. (Volkmann.) Here is an example: Winckel, the elder, had attended a woman affected with osteomalacia, and had employed the Cæsarean operation to deliver her in one confinement. In the course of another gestation this women died. Winckel, the younger, found at the autopsy that death has been due to rupture of the uterus at the seat of the cicatrix left by the Cæsarean section, and also that the osteomalacia which had made this necessary had been entirely cured. All the bones which had been soft and extensible had returned to the normal state; the bones of the pelvis were even more massive and harder than usual. There were osteophytes in a number of places; and synostoses, the result of fractures, were found at the sacro-iliac synchondroses.[1] Therefore recovery is not impossible in the puerperal form. Nevertheless, we must not feel too hopeful when the process is seen to suspend its progress or even to retrograde. It is a perfidious retreat, from which it is the rule for the disease to return with increased intensity. Death ends the scene, less from the progress of the changes in the bone itself than from the disorders and functional disturbances which are its consequence: slow asphyxia, stoppage of the heart, broncho-pneumonia, embolism, thrombosis, impossibility of taking food, diarrhœa, profuse sweats, etc., and the whole train of the malacic cachexia.

Treatment of Osteomalacia.—Therapeutics can do little in osteomalacia. We can only relieve the patient, and delay the fatal progress of the disease, by the following means:—

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[1] Winckel, Monatschrift f. Geburtsh., Mai, 1864.

1. *Hygienic Measures.*—The patient should be placed in dry, warm, and well-ventilated quarters, and should be furnished with abundant and generous food, and all the comfort possible. This is easy to say, but less easy to do. When mastication and deglutition have become impossible or difficult, in consequence of softening of the jaws, the patients must be nourished through the œsophageal tube.

2. *Therapeutic Measures.*—Sulphurous and ferruginous baths have been recommended. But they cannot always be had, and the advice is illusory. All the drugs imaginable have been tried: antiscorbutic, antisyphilitic, antiphlogistic; turpentine, madder, cod-liver oil, iron, cinchona, etc. The phosphate of lime, in spite of the sarcasms of Boyer, is one of the most rational medicaments to employ in all forms of osteomalacia. Phosphoric acid seems also to merit a certain degree of confidence, if we may believe a communication by Prof. Busch, of Bonn.[1] This surgeon has made some experiments upon the action of phosphorus in diseases of the bones. There was no result in caries or rachitis, but, on the contrary, success in two cases of osteomalacia treated with phosphorus. Let us see what was the nature of this success:—

CASE I.—A woman, 30 years old, the disease beginning during her third gestation. In six months the pelvis alone was considerably deformed. Recovery in five months by the use of Wegner's pills, and rest in bed.

But it is confessed that the patient could not be well watched. Perhaps she never took the pills.

CASE II.—A woman, 50 years old, pains beginning in the right arm. At the end of nine months, marked cyphosis and lordosis, curvature of the clavicles, of the thorax, and of the femurs. The patient, lying down almost constantly, could walk only by leaning upon something, and by having the thighs in adduction. The pelvis showed characteristic alterations. At the end of seven months of treatment with phosphorus, she could walk with crutches, which she afterward abandoned, and then walked without support.

The deformities in these patients naturally persisted. Who can say that they will not have a relapse? Binz believes that the action of phosphorus ought to be attributed to a formative irritation, caused by increased oxidation of the tissues. This is why, he says, other agents which have the same relations to oxygen have been able to exert a happy influence; such are arsenious and pyrogallic acid. (Mass, Gies, Binz, Schultz.)

3. *Orthopædic Measures.*—When the disease is fully developed, and the stage of deformity has been reached, it is necessary to prescribe rest in bed in order to avoid fractures and bendings, to secure a suitable position, to place broken or curved limbs in splints appropriate to each case. Bonnet's splint is of great service to prevent fractures or to favor their reunion, to maintain the limbs in good position, and to permit the patient to attend to the necessities of nature without fearing a recrudescence of pain, or the production of fracture. Care must be taken to line the splint with cotton to prevent the formation of eschars.

In spite of all precautions, it will happen, especially toward the end, that the patients cannot longer remain in the large splint. Their wishes should be acceded to, and they should be allowed to assume any posture that they wish, however bizarre and absurd it may seem. They are better judges than we are of their sensations. At this stage the part of the surgeon yields to that of the sister of charity.

Volkmann sums up almost the whole of useful therapeutics in the advice to be given to women affected with puerperal osteomalacia, not to expose themselves to new pregnancies. This advice, and the uncertainties of the pharmacopœia, show clearly the impotence of art in this redoubtable and enigmatic malady.

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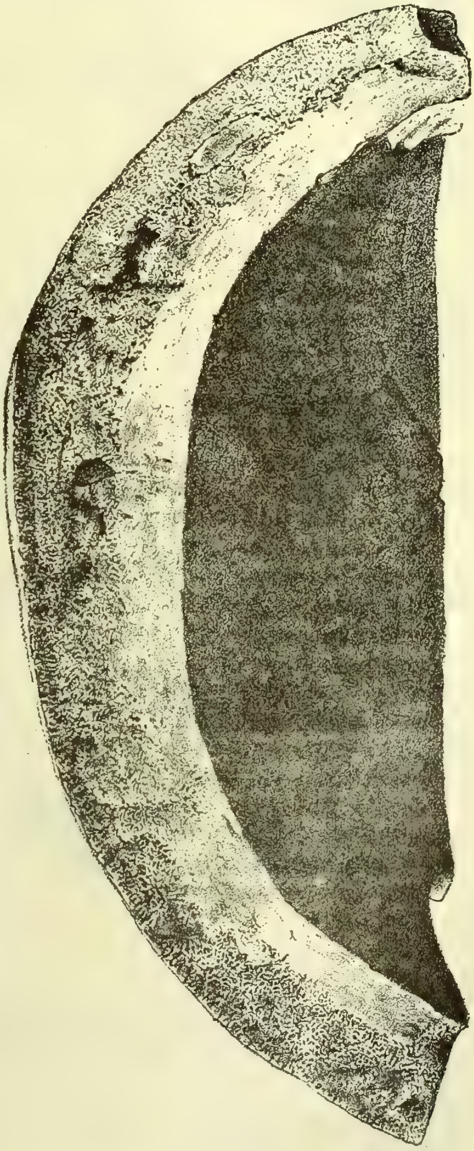
[1] Niederrh. Gesellsch. f. Nat. und Heilk. zu Bonn, 16 Mai, 1881.

OSTEITIS DEFORMANS OF PAGET; BENIGN HYPERTROPHIC OSTEOMALACIA.—Sir James Paget described, on the 14th of November, 1876,[1] under the name of *osteitis deformans*, a disease of the bones characterized by the following features. It commences in or after middle age; it is very slow in its course; it progresses for years without affecting the general health, determining no other troubles than those which result from alteration of the shape, volume, and direction of the diseased bones. Even when the cranium is enormously thickened (Fig. 1458), and when all the bones are extremely altered in their structure, the intelligence remains intact.

Fig. 1458.



Cranium of a man affected with osteitis deformans. Natural size. No. 395 A, of the Museum of the Royal College of Surgeons of London. (After Paget.)

The disease usually affects, in the first place, the long bones of the lower limbs and those of the cranium. It is usually symmetrical. The bones increase in size and soften. The affected portions of the skeleton which have to bear the weight of the body, are bent and deformed by the abnormal curvatures which they assume. (See Fig. 1459 and Fig. 1460.) The natural curves of the vertebral column increase, and from this results a considerable diminution of the height of the patient, which has already undergone considerable reduction as a result of the bending of the diaphyses of the tibiæ and femora, and the lowering of the heads of the latter, the necks of which become almost horizontal. It is an important point that this softening, this loss of resistance, is accompanied neither by weakness of the limbs nor by fracture. The legs remain strong and in condition to support the weight of the body. They bend and do not break. In the first stages, or sometimes from the beginning to the end, the disease is accompanied by pains in the affected bones. They are taken to be those of rheumatism, of chronic periostitis, of syphilis, of gout, of neuralgia, etc. There is never fever, nor anything abnormal in the urine. There is no association with syphilis, or any other constitutional disease except cancer. For, in the first five cases of Paget, there were three in which cancer showed itself toward the end of life. Is this a simple coincidence? At any rate, Paget himself recognizes that this point demands examination. There are in the museums, at Guy's Hospital especially, specimens of symmetrical osteoid cancer of the iliac bones, with cancer of the vertebral column and of the cranium—specimens in which the walls of the latter show hypertrophy comparable to that of *osteitis deformans.* In the first case of Sir James Paget, there were cancerous nodules in the walls of the cranium. The bones of this first typical patient (see Figures 1459, 1460, and 1461), were examined microscopically by Mr. Butlin. There was a peculiar inflammation, affecting, in the cranium, the whole thickness of the bone; in the long bones, chiefly the compact layer of the walls of the diaphysis, as well as that of their articular surfaces. It is probable that these changes were inflammatory from the beginning, because the softening was accompanied by thickening (see Fig. 1461), by proliferations of imperfectly formed bone, and by hyperæmia. Mr. Butlin asks, Does the inflammation persist to the end; or, after having lasted a number of years, does it give place to the reparative processes of consecutive eburnation? It is not known. But it is known that the inflammatory nature of the disease is incontestable. The Haversian canals (see Fig. 1462) are enlarged by

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[1] On a form of Chronic Inflammation of the Bones, Osteitis deformans. (Medico-chir. Trans., vol. lx.)

Fig. 1459.

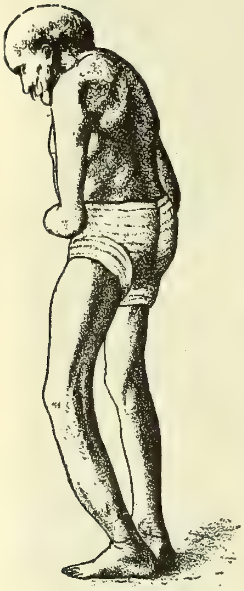


Fig. 1460.

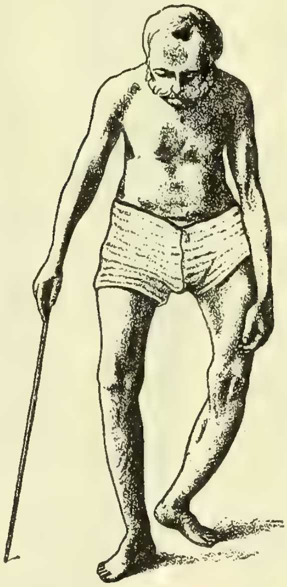
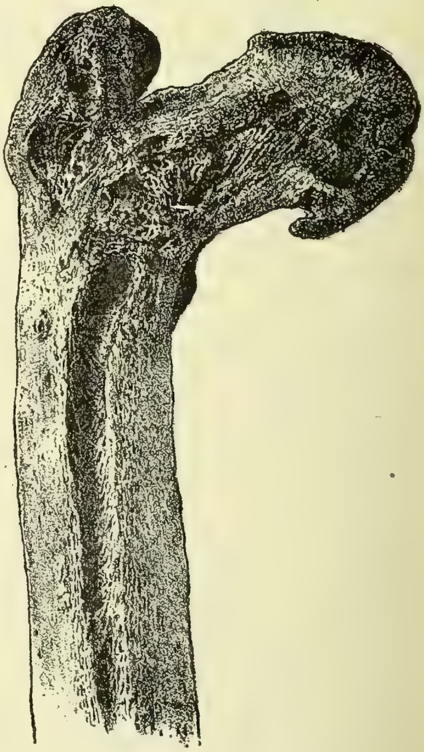


Fig. 1461.

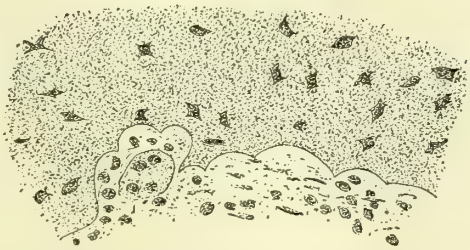


Figures 0017 and 0018. Osteitis deformans, from photographs taken six months before the patient's death. (After Paget.) Notice the curvature of the lower limbs, and the arching of the back.

Fig. 0019. Section of the upper end of the patient's right femur. Half natural size. (Museum of the Royal College of Surgeons, No. 385 B.)

lacunar erosion, as they are in every inflammation of the bones. (Compare with Fig. 1457, osteomalacia.) The marrow which they contain is remarkable for its richness in fibrillar cells, which indicates its tendency to stable organization. Chemical analysis made by Dr. Russel has been almost negative. In cases examined in future, it will be well to ascertain before decalcifying with acids (which Mr. Butlin failed to do), if the eroded edges of the Haversian canals are decalcified by the mere fact of the disease, as Rindfleisch has shown to be the case in malignant osteomalacia. This is a capital point. Since his first paper, Paget has added seven new cases to the five which he had previously published.[1]

Fig. 1462.



Histological preparation of one of the tibiæ, to show the eroded outlines of the enlarged canals of Havers. Oc. 3, obj. 7. × 200. (After Paget.)

In 1881, Mr. Treves[2] published an account of a case of *osteitis deformans* in a woman, who had had twelve children and two miscarriages, and several of whose children had been affected with rachitis. This woman had manifested for a year the signs of the bone-disease, when she had her twelfth child, which had a grave form of rachitis and died at the age of three years and a half. I have not been able to procure two papers on this subject; that of Symonds[3] and that of Ellinwood.[4]

Prof. Ollier has seen several cases of this kind. He has mentioned to me, among others, the case of a woman affected with local osteomalacia (as he calls this affection) situated in the tibia, which he has had under treatment since 1866.

Diagnosis.—I think it useless to give the differential diagnosis from the ordinary forms of hyperostosis; there are so many differences between them and osteitis deformans that confusion is not possible when the latter is known. The preservation of the general health for years, the slow curvature of the long bones, which always remain capable of resisting the muscular contractions and of supporting the weight of the body, are the characteristics which distinguish osteitis deformans from all the known processes of hyperostosis, and there are, in fact, only two diseases with which it can be confounded: rachitis and osteomalacia.

Rachitis ought, in my opinion, to be entirely eliminated; since rachitis is a disease of the bones in the process of growth, and osteitis deformans is a disease of formed bone, and occurs in adults. A comparison can be made only with osteomalacia, which is also a disease of formed bone. Paget mentions, as a difference, that "in osteomalacia, the walls of the bone become exceedingly delicate and thinned, as in acute atrophy, and when they bend it is not with a regular curve, but with an elbow or angular fracture." He says, finally, that on account of the only characteristic which they have in common, that is to say, osteoporosis of the cranium, these three diseases—rachitis, osteomalacia, and osteitis deformans—are constantly confounded in museums.

Nature.—I shall not venture to take up the question of the nature of this disease, as the collected cases are not yet numerous enough, and as I have not had opportunity to examine personally bones thus affected. Yet the microscopical examination made by Mr. Butlin, although incomplete, and the clinical history, seem to me to require that this affection should be put with true osteomalacia, as a benign and hypertrophic variety. It is, perhaps, to this form that a certain number of cases belong in which cures have been noted, with or without the aid of therapeutics. There is hyperostosis, because, the inflammation being moderated, the phenomena of repair on the part of the periosteum and the medullary canal are not obliterated by the concomitant phenomena of absorption, which occur in the canals of Havers. Curves occur in the long bones which support the weight of the body, because the medullization of the compact layers and the formation of new bone-tissue, which is also areolated and laminated, diminish the resistance of the bone. The bending does not go on to fracture, nor to angular curvature, because the conditions of resistance are not destroyed, but only lessened. In the grave form of osteomalacia, absorption is so rapid that it prevents or destroys all deposition of bone, and the bones reach the state of softness and want of consistence which I have already described. But, in one, as in the other, it is fundamentally the same process; here inevitably reaching its culmination more or less promptly; there remaining in its stage of commencement and manifesting itself in a more benign manner. This is why I propose to designate that which Sir James Paget has described under the name of *osteitis deformans*, by the name of *benign hypertrophic osteomalacia.*

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[1] Additional cases of Osteitis Deformans (loc. cit., 1882).

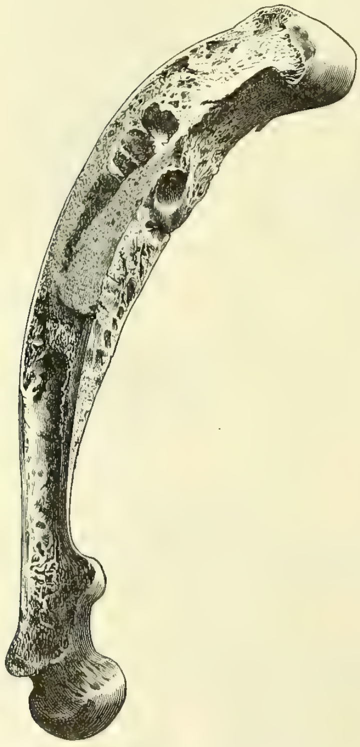
[2] Trans. Path. Soc. London, 1881.

[3] A case of osteitis deformans (Guy's Hosp. Rep. London, 1881).

[4] Osteitis deformans (Western Lancet. San Francisco, 1883).

PSEUDO-MALACIA OF INFLAMED BONES.—It is rather a state of softness than of softening of the bones which I wish to designate by the name of pseudo-malacia of inflamed bones. By this I mean the bending, the curvature which is produced in the diaphysis of a long bone during the stage of repair of an osteopathy, which has given rise to a large sequestrum and ultimately to the formation of an ensheathing shell. This shell, which is composed of young bone-tissue, and the neighboring parts, which are medullized by reactionary inflammation, have not much consistence, for lack of calcification of the abundant organic matter which enters into their composition. They are susceptible, consequently, of bending under the weight of the body when the patient walks too soon, or simply from the weight of the limb, if it gets crooked in the bed, if it is placed in a defective position. Muscular contraction may also contribute to these deformities; whence the importance of supporting the limbs in good splints. It is especially in the tibia and in the femur that deformities from this cause are seen after juxta-epiphyseal osteitis. It is reasonable to suppose that in a patient with early or delayed rachitis, this defect or this slowness of calcification of the periosteal or medullary osteogenic elements would occur with greater ease than in another subject. I am not aware that such cases

Fig. 1463.



Section of a femur curved in consequence of inflammatory softening. (From the collection of M. Ollier.)

have been observed except in the period of growth. Here is a subject for investigation. I know nothing comparable to it in adults, except the delayed calcification of callus in fractures. The femur is sometimes seen to become curved when the patient, after a fracture of the shaft of the bone, is in too great a hurry to use it. Here, as in the cases to which I have alluded in the first place, the bone-tissue is defective rather in quality than in quantity; it still contains too many cartilaginous or fibrous elements, and it lacks density and cohesion.

Lobstein records two cases which were taken to be true osteomalacia, and which belong to the category of the morbid condition which I am now describing:—

> Von der Haar speaks of a girl, about fifteen years old, who, after an exanthematous fever, had in the right arm and in the left leg an erysipelatous inflammation which terminated in abundant suppuration, necessitating a number of incisions, by means of which there was discovered not only enlargement of the bone, with caries, but also softening of the tibia and fibula, so that these bones bent when the leg was lifted by the heel, and curved like a bow when the limb was left to support its own weight. As a result of appropriate treatment, these bones recovered their former solidity; but it was noticed that they became deformed and thickened, and were at the same time shortened. "Here," says Lobstein, "is a well-marked case of acute osteomalacia, caused by metastasis one month after an exanthematous fever." The same author reports a second example of softening, observed in the femur of a boy, nine years old, who, excepting smallpox, which he had had at the age of seven years, had had no other disease except an acute fever with delirium, which degenerated into a slow fever. Forty days after the onset of this acute fever, there appeared a large tumor on the right thigh, which was at the same time bent and curved forward and outward. After free suppuration, and the exfoliation of a number of sequestra, his health was restored; his thigh-bone recovered its solidity, but remained enlarged and a little shortened.

Here, I would say—thanks to the investigations of M. Ollier in regard to juxta-epiphyseal osteitis and the pathological growth of bones—here are two well-marked cases of juxta-epiphyseal osteitis, the first following an exanthematous fever and causing an arrest of growth; the second coming on with an acute fever, terminating in abscess with elimination of a number of sequestra, accompanied by the formation of sub-periosteal layers of bone and medullization of the old bone, with curvature from contraction of the inner muscles of the thigh, and finally arrest of growth from excessive irritation (as in the first case) of the epiphyseal cartilages. There is not a surgeon who has not seen cases like these. It is to the same causes that I should refer fractures of the invaginating shells of sequestra, after the elimination or extraction of the latter, when the patient rises too soon, before eburnation of the bone-tissue has taken place, and when it is deprived of support by a splint or brace.

ATROPHY OF THE BONES; SENILE AND FATTY OSTEOPOROSIS.—I shall omit from this section certain arrests of development which have been improperly classed with atrophy; such as *congenital aplasiæ* affecting the whole skeleton (dwarfishness), or a part alone, as, for example, microdactylism, certain forms of club-hand, club-foot, etc.; such as *aplasiæ in young subjects*, from want of use of the limbs, from lesions of the cartilages of growth, from lesions of the joints or of the diaphyses which affect these cartilages secondarily; such as *neurotic aplasiæ*, in children affected with spinal paralysis; such as arrests of development following *resections* or *amputations;* such as aplasic malformations of the *cranium*, or of the *pelvis*, in young subjects who have premature or abnormal consolidation of the bones which compose these osseous cavities. All these questions, associated with the laws of physiological and pathological growth, have been treated of by M. Ollier in connection with osteitis in general. As complementary information, I would refer to the very remarkable thesis of M. Gabriel Mondan,[1] prepared under the direction of M. Ollier.

I wish to speak here only of the atrophic phenomena which occur in completely formed bones, at a period when an individual has finished growing, and which are of a nature to diminish the solidity of the skeleton by absorption of the bone-substance without the bone becoming softened.

Two sorts of atrophy may be distinguished: One *eccentric* (called also internal atrophy by Curling); the other *concentric*. In *eccentric atrophy* neither the shape, nor the size, nor the external contour of the bone undergoes alteration. The marrow of the medullary canal and of the alveoli of the spongy tissue, as well as that of the Haversian canals, increases in quantity at the expense of the compact elements—of the lamellæ, of the trabeculæ, of the bone-tissue properly so called. It follows that the cortical layer becomes more and more thin; that the walls of the alveoli are absorbed, are thinned, until they gradually disappear. The union of a number of alveoli in the spongy tissue gives rise to more or less spacious medullary lacunæ. This process continuing, the medullized tissue of the cortical layer may disappear in great part from within outwards, and there will remain at the end only a bony envelope as thin as a sheet of paper. This eccentric atrophy, which occurs in old persons in variable degree under the sole influence of age, may be manifested in young subjects in certain pathological conditions. Senile atrophy has also received the name of senile osteomalacia; an improper term, since the bone is not softened. The quantity of bone-tissue diminishes, but that which is left preserves all its constituent elements, as Nélaton has proved. The expression senile osteoporosis is more exact and more in accord with histological revelations, which, according to Cornil and Ranvier, are the following: Senile osteoporosis is "a rarefaction of the bone-tissue by enlargement of the medullary spaces. In this case the friability of the bone is connected simply with its rarefaction. There is not here, as in true osteomalacia, softening of the bone by decalcification. This rarefaction of the bone is accompanied by important modifications of the medulla. These modifications present a certain analogy with those seen in true osteomalacia. They consist in the disappearance to a greater or less degree of the fat-cells, and in the formation of cells like those of the fœtal marrow. Sometimes there is produced in the medullary spaces young connective tissue of new formation. The bones most frequently affected in this disease are the ribs and the vertebral column. The vertebral column becomes incurvated, fractures take place in the ribs on the slightest effort, and—which is quite a curious thing—they consolidate perfectly by the formation of cartilaginous callus which afterwards ossifies."[2]

In patients who have not reached old age, rarefaction of the bone-tissue (fatty osteoporosis) is observed after chronic affections of the joints, and after prolonged immobilization of the limbs. In a Syme's amputation for fungous osteoarthritis of the calcaneo-cuboid joint spreading to other parts, which had condemned the patient to bed for two years, I found the uninflamed part of the calcaneum and of the other tarsal bones so atrophied that they crumbled between my fingers; the tibia was in the same condition—when cut, its enlarged alveoli poured out a material like oil.

Fatty osteoporosis is a rarefaction of the bone-tissue "characterized by an abundant production of adipose cells in the medullary spaces and in the

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[1] Recherches expérimentales et cliniques sur les atrophies des membres dans les affections chirurgicales, système musculaire et système osseux. Lyon, 1882.

[2] Op. cit., p. 388.

Haversian canals. The bony trabeculæ of the spongy tissue first become very thin, and end by disappearing. The bone is then reduced to a parchment-like shell pierced with numerous vascular openings."[1]

There is no occasion to confound this state of fatty atrophy—which is produced still more quickly in the same conditions in old people—with fatty degeneration of the bones. The fatty condition of the bones in obese persons is not preceded or accompanied by rarefaction of the proper bone-tissue, or only to a slight degree. Lipoma of the bones is extremely rare, and its existence is even questioned by Virchow, who regards it as an exostosis containing large masses of fatty marrow. However this may be, there is present in such cases a circumscribed fatty tumor, and there are no bony partitions in its substance.

In *concentric atrophy*, the bone diminishes in size from without inwards, the transverse diameter, the thickness, diminishes. The long bones are not shortened, or only to a slight degree. The essential process of this sort of atrophy is little understood. It is probable that it consists in progressive and insensible medullization of the superficial layers of bone, and in the absolute cessation of all periosteal proliferation. Concentric atrophy does not exist alone, it is accompanied by eccentric atrophy, for the bones, the size of which is lessened, always have an enlarged medullary canal; and this double effect of the same process ends in rendering the bones more light. In adult animals, M. Mondan found the bone, after an amputation, affected with slight atrophic modifications. The total size of the bone "undergoes a reduction inappreciable by measurement, but one which nevertheless is obvious to the eye;" it becomes in fact "the normal reduction of the bone." (Ollier.) "It is reduced in all its dimensions, in its apophyses, in its ridges. At the same time its medullary canal is enlarged, and undergoes what Curling calls eccentric atrophy; but these phenomena are a long time in being manifested, and before they are clearly appreciable to the sight, weighing alone can enable one to decide the question."[2]

Atrophy of the bones is due to two principal etiological causes: *inactivity* and *senility*. As examples of the first category of cases, I will mention the atrophies of bone which are seen in old palsies, and in chronic inflammations and prolonged suppurations of the bones and joints, which, because of pain and the requirements of treatment, condemn the limbs for a long time to rest. I will cite also the diminution of capacity of the natural osseous cavities, the contents of which disappear or diminish; for example, the diminution of capacity of the orbit after wasting or enucleation of the eyeball; the diminution of capacity of the cotyloid cavity after an unreduced luxation of the hip, a diminution which may be rapidly carried so far that the head of the femur, which undergoes little concentric atrophy, can no longer be replaced. This is not a matter of retractility of the bone-tissue, as has been asserted.[3]

It is a general rule that portions of bone out of use undergo atrophy. Thus, as Curling[4] has said, the bones, like the soft parts, fade away and waste when their activity is lessened or their function is suppressed. This author thinks that atrophy ought in some of these cases to be attributed to a diminution of the nervous influx,[5] but usually to a lowering of the circulation. As an example, he cites eccentric atrophy—accompanied by absence or retardation of consolidation—of the fragments which, in fractures of the femur, do not keep the nutrient artery of this bone. He is mistaken in including osteomalacia among the atrophies; these are pure and simple rarefactions of the bone, whilst in osteomalacia the decalcification appears to be primary, and to constitute the predominant phenomenon.

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[1] Ibid., p. 389.

[2] Mondan, op. cit., p. 139.

[3] See Richet, Anatomie Chirurgicale.

[4] Curling, loc. cit.

[5] J. Wolff, anticipated as we see by Curling, has just published a work in which he makes atrophy of bone to depend upon an osseous tropho-neurosis.

According to Curling, senile atrophy is also due to a defect of nutrition. It begins in the neck of the femur because this part of the skeleton is but slightly vascular. Senile atrophy resembles that of mollities ossium, he says, although to a less degree; and as there is usually a superabundance of phosphates in the bone-tissue, fractures are more frequently seen than softening. These propositions rest upon gross appearances. The two processes are absolutely different, as we have seen. All the osseous system of old persons is more or less affected with atrophy; but, when this physiological condition is quite accentuated, it becomes a morbid condition. Then it is that fractures occur with the greatest facility. Old persons have been seen to break their jaws while eating. The inferior maxilla, which is always reduced in size (concentric and eccentric atrophy), may be no more than a rim of bone. The scapulæ, the iliac bones, and the bones of the cranium, may be thinned to such a degree that parts of them may be placed directly under the microscope. (Volkmann.) They are sometimes even pierced with quite large openings.[1] Similar atrophies may be met with in patients who are cachectic although young. It is perhaps in this category that should be placed the perforated cranium (of a girl from 13 to 16 years old) which M. Charpy showed me. Aplasia and atrophy contribute to the same result in young cachectic persons.

Senile atrophy, whether premature or coming on at the time fixed by nature, predisposes, it will be understood, to fractures, among which that of the neck of the femur is the most common.

Fatty osteoporosis, brought about by inaction, also creates a predisposition to fracture, though less marked.

The prognosis of fractures in atrophic states of the bones is sufficiently unfavorable, because of the general condition of the patients; and it is made more gloomy by the danger of sudden death from fatty embolism. It is a matter of observation, also, that bones in fatty atrophy supply one of the most favorable soils for the evolution of septo-pyæmic processes (acute septic osteomyelitis), when, in a compound fracture, in an amputation, or in a resection, etc., the precepts of the antiseptic method have not been followed. These accidents, very happily, pertain somewhat to ancient history. The anatomico-physiological conditions of the vascular circulation and the absorbing power of the osseous medulla, and the increase of the latter, explain the rapidity of septic poisoning.

Treatment is disarmed in the presence of senile osteoporosis, as in the presence of an inflexible law of nature. It should be limited to improving the patient's food and hygienic surroundings, if this be necessary, especially when the atrophy is very pronounced. When fractures occur, they should be treated as those of normal bones, always remembering, in order to palliate them, the inconveniences of confinement to bed in old persons (pneumonia, fatty embolism, digestive disturbances, eschars).

In fatty osteoporosis caused by inaction, in non-senile patients, it may be hoped that good food and better hygienic conditions may renew the vitality of the tissues. After and during the employment of these general measures, recourse should be had, as soon as possible, to means of curing the disease which condemns the patient and the limb to inactivity; that is to say, curing the anchylosis, the osteitis, the arthritis, etc. In operative procedures it is important to remember the fragility of the bones, in order to avoid breaking them.

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[1] See Feré, Atrophie sénile des pariétaux. (Progrès Méd., 1882.)

Wasting of the Bones.—I cannot omit speaking of a sort of atrophy which has received the name of "wasting of the bones." It is caused by abnormal, persistent compression. A benign or malignant tumor, pressing against the bone, is the commonest agent in producing it. Its pressure, irritating the tissue of the bone, causes its insensible absorption by a process of medullization, analogous to that which is produced experimentally in animals by surrounding their bones with elastic bands or with a simple unoxidizable platinum wire. Further, there have been noted under these tumors rugosities on the surface of the bones, which have undergone losses of substance, wastings by compression. Sclerosis has also been observed, which may be accompanied by medullary ossifications capable of obliterating the central canal of the long bones. The whole thickness of the diaphyseal wall of these bones may be thus progressively wasted. The continuity of the bone may even be totally interrupted. For example, neoplasms of the dura mater have been seen to perforate the cranium, naso-pharyngeal polypi to penetrate into the cranial cavity by perforating its base by wasting, and aneurisms to perforate the sternum and the vertebræ. The pulsatile expansions of aneurisms and very vascular tumors determine more quickly these local atrophies by compression. Cancer, according to Volkmann, can sometimes only exercise a local atrophying effect by invading the connective tissues of the Haversian canals and of the medullary spaces. In order to have a true cancerous degeneration, it is necessary for the cancer to reach the bone-corpuscles or to proceed from them. The fact is that in cancerous persons the bones are sometimes very fragile, and that, in many cases, cancerous material has been found at the seat of fracture. In unreduced luxations and sub-luxations, the abnormal pressure of the bones, one upon the other, gives rise to the phenomena of wasting which sometimes lead to the formation of a movable or anchylosed false joint. In the joints, an abnormal position, with or without contracture, may finally bring about atrophy of the cartilages and of the portions of bone which are in contact, and afterward union of the latter.[1]

I may remark, in a general way, that, in very extensive atrophy of the bones, of whatever sort it may be, the excess of phosphates in the economy—especially if the kidneys are acting inefficiently, as is often the case in diseases of the bones—may favor and explain the formation of abnormal calcifications in the tissues and in the organs, not to speak of renal and vesical calculi. (Scarpa, Ribes, Virchow, Volkmann.)[2]

Idiopathic Fragility of the Bones.—The progress of pathological histology may perhaps some day erase this term from the nosology of the bones. Meanwhile, this name is given to a condition of the bones, still unknown as far as histology is concerned, which is characterized clinically by an extraordinary proneness to fracture. In the midst of perfect health, with bones absolutely normal in appearance, some persons break their limbs without apparent reason: in turning in bed, in making a sudden movement or a false step, or as the result of a trifling fall. It has been claimed that this predisposition appears to be congenital. It is probable that the bones in such cases have been affected by intra-uterine rachitis, or by rachitis coming on soon after birth. Is this predisposition hereditary? Volkmann says that it is, and adds that it increases in intensity from generation to generation. It has been said that the female sex is most apt to exhibit this fragility, especially in old age. Certainly the skeletons of women have normally less power of resistance than those of men. One ought to be very careful not to confound in old age, especially in women, the fragility of the bones which results from senility—which is sometimes very precocious in women who have had many children, and an unhappy life, full of all sorts of privations—not to confound this, I say, with essential fragility. In very young patients one should rather think of rachitis, and not speak of idiopathic fragility unless rachitis is absolutely absent.

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[1] See B. Teissier (de Lyon), Thèse.

[2] Dr. Samuel Gee has published in St. Bartholomew's Hospital Reports, vol. xvii., an article, entitled: On osteal or periosteal cachexia. The cachexia, he says, in place of provoking atrophy, causes tumefaction of the bones. The facts are not clear; for there is a question of rachitis, of osteomalacia, and of syphilis.

With these reservations, I will mention without comment that cases are recorded of unfortunate possessors of essentially fragile skeletons, who, after having sustained an incalculable number of fractures, became smaller and smaller, in consequence of the over-riding of fragments. At the Middlesex Hospital,[1] there was a girl fourteen years old, otherwise perfectly well, who had had thirty-one fractures since the age of three years; among other bones, she had broken one tibia nine times. What distinguishes these fractures from other conditions of fragility of the bones, is the ease and rapidity with which they are repaired.

What is the real cause of essential fragility of the bones? It is evidently a disturbance of nutrition or of composition; but which? Only vain hypotheses can be suggested, as long as no autopsy has been made, and no examination of the bones, either microscopical or chemical. The ancients often noted fragility of the bones as a consequence of scurvy. From the oldest times syphilis has been accused of rendering the bones friable, especially when the treatment involved salivation. The fragility of the bones in scurvy and syphilis is not an idiopathic fragility, since it is consecutive to the rarefying osteitis caused by those diseases. In syphilis the bone may also be fragile because it is the seat of a gumma. There have even been examples of this in children, as in Behrend's case, in which there were spontaneous fractures of the humerus and femur in a child eleven months old, with congenital syphilis.[2] I have already said what I think of fragility of the bones in cancer. In the case of all neoplasms complicated with fracture, whether spontaneous or caused by trifling traumatism, there can be no question of essential fragility; the bone breaks easily, either because it is invaded and destroyed by the tumor, or because the pressure of the latter has diminished its volume, its thickness, and its power of resistance by wasting.[3]

Idiopathic fragility naturally remains unrecognized as long as the fractures are not multiplied. It is distinguished from osteomalacia by the absence of acute pains and of softness of the bones. The patients who are affected with it are otherwise perfectly healthy.

Treatment can be addressed only to the fractures. It is necessary to guard against vicious union, which alone is the cause of deformity in this singular disease, or tendency, of the bones. Some day, perhaps, the progress of histo-chemistry will enable us to attribute it to a cause over which therapeutics may have some control. At present we are limited to the common prescriptions of food and hygiene.

Syphilis of the Bones.—Syphilis of the bones might properly be described in connection with the preceding affections, but has already been sufficiently considered in a previous volume.[4]

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[1] London Med. Gazette, vol. xii., 1853.

[2] Berlin. klin. Woch., No. 30, 1882.

[3] See page 971, *supra.*

[4] See Vol. II. pp. 481, 539, 563, *supra.*

TUMORS OF THE BONES.

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Among surgical affections, tumors of the bones are quite common lesions, and the same neoplasms are met with in bone-tissue as in the soft parts. It is hard to classify these tumors satisfactorily. Pathological anatomy, taking into consideration the elements which compose them, their form, and their disposition, furnishes many distinctive signs which are of great importance; but there are certain problems of which it cannot yet be expected to furnish the sole solution.

The grand and eminently practical division of tumors into benign and malignant, should then be maintained for the neoplasms of bone. Indeed, whatever may be the progress realized in the domain of pathological histology, it is important not to lose sight of the fact that it cannot at the present time furnish by itself a positive indication of the course, evolution, and prognosis of a tumor. Clinical surgery can see in it only a new means of investigation, and, under the present order of things, is most often obliged to draw its materials for judgment from signs long familiar.

Yet if we seek to class tumors of the bones in the ranks of benignity or of malignity, we shall not be long in discovering that, as is also the case in every general classification of tumors, a variety which is usually benign may, under some more or less well-defined circumstances, become malignant. The name of the tumor alone—myxoma, chondroma, sarcoma, for example—cannot furnish sufficiently exact indications in regard to its evolution. Thus a chondroma of the phalanges, or of the metacarpal bones, may for long years, or even during the whole life, cause only functional disturbances, while a chondroma of the lower end of the femur, or of the upper end of the humerus, may rapidly increase in size and behave like a malignant tumor, infecting the whole system, and often becoming generalized. I could multiply illustrations of this sort in regard to sarcoma, as it occupies the gums, the edges of the alveoli, or the ends of the long bones; but I shall have occasion to return to facts of this nature. What it is important to know is, that tumors of the bones behave differently, and have a different prognosis, according to the age of the patient and his hereditary condition, and according to the seat of the lesion and the particular bone affected.

Considering only pathological anatomy, tumors of the bones include: exostoses, fibromata, myxomata, lipomata, chondromata, osteoid tumors, myeloplaxic and medullary tumors, spindle-celled sarcomata, epitheliomata, encephaloid and other carcinomata, lymphadenomata, simple cysts, hydatid cysts, and vascular or pulsatile tumors. I shall describe these different varieties separately; their study will thus be more simple and more classical. I cannot, indeed, for reasons already given, adopt a classification according to the degree of benignity. Yet I would remark here that, from a clinical point of view, exostoses, lipomata—which are so rare that their existence is questioned—cysts, and pulsatile tumors—sometimes called aneurisms of the bones, and also very rare—belong to the category of benign tumors. Other tumors which are often benign, are sometimes malignant: fibromata, myxomata, chondromata; and the same is true of certain neoplasms called myeloplaxic and medullary tumors, grouped under the name of myeloid growths. Finally, the really malignant tumors are: sarcomata, epitheliomata, carcinomata, and osteoid tumors.

Exostoses.

By the name exostosis, is meant an abnormal and circumscribed production of bone-tissue, on the surface or in the interior of a bone. (Duplay.) In the latter situation, the masses protruding into the interior of the bone have often been designated by the name of *enostoses;* but usually the name exostosis is employed in the general sense which I have attributed to it in the definition.

Before entering upon the study of exostoses, it will be well to differentiate them first from other abnormal productions of bone.

In the first place, when a long bone is more or less uniformly increased in size in its whole length, or in a considerable part of its extent, by the formation of new layers of bone, the name *hyperostosis* is given to the lesion. On the other hand, in the neighborhood of old bone-lesions, or even sometimes of lesions of the soft parts, as in old ulcers of the leg, masses of bone, to which the name *osteophytes* have been given, are seen to form. In a word, in order to have exostosis, it is necessary: 1. To really have a tumor.[1] 2. This must be made up of true bone-tissue (this is why odontoma is entirely distinct from exostosis). 3. The tumor must have its starting-point in one of the constituent elements of bone; which enables us to eliminate certain neoplasms called *parosteitic osteomata* by Virchow. This author has designated by the name *apophyseal exostoses*, exostoses beginning as ossifications in the portions of tendons attached to the bone; the production of bone is afterwards prolonged into the tendons in the shape of long needles. In some cases, from twenty-five to fifty such prolongations have been found upon the skeleton.

History.—The older authors, and more lately J. L. Petit, Boyer, and Sir Astley Cooper, confounded under this title different tumors, grouping under the same designation both sarcomata and carcinomata. More recently the different varieties of exostosis have been confounded. The first precise account of the exostoses of development, appeared in the thesis of Dr. Soulier, in 1864,[2] and in regard to this variety, the thesis of Dr. Labarthe[3] and the clinical lectures of Professor Gosselin[4] may be consulted with advantage.

Pathological Anatomy.—Exostoses were formerly divided into *eburnated exostoses* and *spongy exostoses.* Cornil and Ranvier divide them, like the osteomata into: (1) *eburnated exostoses*, (2) *compact exostoses*, (3) *spongy exostoses.*

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[1] Heydenreich, Dict. Encycl, etc.

[2] Du parallélisme parfait entre le développement du squelette et celui de certaines exostoses (Thèse.) Paris, 1864.

[3] Thèse de Paris, 1871.

[4] Clinique Chirurgicale de l'Hôpital de la Charité, 3e édition. Paris, 1878.

(1) *Eburnated Exostoses.*—The lamellæ of bone are parallel to the surface of the tumor. In the midst of the lamellæ are seen bone-corpuscles, the canaliculi of which are almost all directed toward the periphery. No vessels can be distinguished in them. (Virchow, Cornil and Ranvier.)

(2) *Compact Exostoses.*—The bone-tissue recalls that of the diaphyses of the long bones. The bone-substance is arranged in concentric lamellæ surrounding the vascular canals. The canals of Havers have a less regular direction than in the shafts of the long bones. The bone-tissue may be whiter, the osteoplasts more regular.

(3) *Spongy Exostoses.*—Their structure is that of the spongy or areolar tissue of the bones. The contained marrow is embryonic, gelatinous, fibrous, or fatty. Exostoses which are at first spongy may be modified, and may become compact, or conversely.

If the seat of the exostoses be considered, and not their structure, they may be again divided, according to Cornil and Ranvier, into (1) *epiphyseal exostoses*, projecting on the surface of the bone like supplemental epiphyses; (2) *parenchymatous exostoses*, developed in the thickness of the bone; and (3) *enostoses*, situated in the interior of the bone.

(1) *Epiphyseal Exostoses* (Cornil and Ranvier).—This form of exostosis is met with on all the bones. It has been seen on the bones of the cranium, and in this case it is generally associated with syphilis. It has also been met with on the short bones. I saw in a young man of seventeen, in the Croix-Rousse Hospital, two symmetrical exostoses, situated on the internal surface of the calcaneum. These exostoses are also seen on the phalanges; witness the sub-ungual exostoses of the great toe, and of the phalanges of the fingers. The new tissue and the old are easy to recognize in a section. The new tissue is applied over the lamellar systems of the old bone, without their destruction. These exostoses are generally developed under the periosteum in consequence of a proliferation of the sub-periosteal medulla; the direction of the lamellæ, being determined by that of the osteo-periosteal vessels, is perpendicular to the surface of the bone.

(2) *Parenchymatous Exostoses.*—This form of exostosis has its birth in the thickness of the bones. In consequence of a rarefying osteitis, there occurs a loss of substance, filled up by inflammatory medullary tissue, which becomes the starting-point of an exuberant production of bone. (Cornil and Ranvier.)

(3) *Enostoses.*—These tumors, which are usually formed of compact tissue, more or less fill the central canal of the bone. Sometimes they form simple nodules; sometimes they are diffuse. They are not perceptible on the outside, except as they have thrust out the bone which surrounds them, and which incloses them with a bony capsule which may afterwards be perforated. Certain authors have designated as *enostoses* tumors which protrude into a cavity like that of the cranium. I believe that the name ought to be reserved for growths which are inclosed within bone, and not applied to such as protrude from it. In some cases enostoses may be, at the same time, parenchymatous exostoses.

If we regard the shape of exostoses, they are seen to present numerous varieties. Some have the shape of an appendix, a spine; others are pedunculated, or sessile; and, finally, there are some which by their extent resemble hyperostoses. The size of an exostosis may in some cases equal that of an adult's fist. These tumors are sometimes propagated from one bone to another. They have been seen to fill up the space occupied by a suture, or by an interosseous ligament. They often respect the vascular canals. In chemical composition, the exostoses contain more phosphates and less carbonates than normal bone. They have been observed on all the bones of the skeleton, but more frequently on the superficial bones; perhaps those of the deeper bones are harder to recognize. They are found preferably, however, on the long bones of the limbs, and on the bones of the skull and face.

In a patient in the wards of the Hôtel-Dieu of Lyons, I saw some years ago multiple exostoses. All the extremities of the long bones were the seat of hard tumors, of exostoses, some of which were the size of a fist. The patient, who was forty years old, was not incommoded by the tumors. These variously shaped osseous masses occupied the ends of the long bones—to be more exact, the juxta-epiphyseal portions—a point upon which Broca and Soulier have dwelt. They were also, by their greater development at certain juxta-epiphyseal portions, a new clinical demonstration of the laws formulated by Professor Ollier[1] in regard to the growth of the long bones.

Etiology of Exostoses.—Sometimes, in consequence of a contusion, of a blow, there is developed on the surface of a bone a slow inflammatory process ending in the formation of an exostosis. Under other circumstances, in consequence of an inflammation of neighboring parts, as in certain cases of rebellious ulcer, masses of bone are formed, varying from an osteophyte to an exostosis. Syphilis often causes the production of exostoses; and generally on the bones of the skull.

These three classes comprise all the forms of exostosis which can be called *symptomatic.*

By the side of these *symptomatic exostoses*, Soulier classes the *idiopathic exostoses*, which he divides into two categories: *Osteogenic* exostoses, or exostoses of development, and *autogenic.* The latter are those in which none of the causes which I have mentioned are recognized. They have become more and more rare in proportion as a more rigorous investigation of the history and antecedents of the patients has been made. Heydenreich does not hesitate to exclude them. I believe that we may properly follow him, and retain in our classification:—

Idiopathic exostoses,	Osteogenic, or of development.	
Symptomatic exostoses	From a local cause,	Traumatism. Neighboring inflammation.
	From a general cause,	Syphilis.

Osteogenic Exostoses, or Exostoses of Development.—It is, as I have said, only since the thesis of M. Soulier that a clear idea has been formed of exostoses coming on during growth, and keeping pace with the development of the skeleton. These exostoses have sometimes been called *epiphyseal exostoses.*[2] I shall reject this denomination, as it suggests the inference that these bone-tumors are developed habitually on the epiphyses—which is not the case—and as on the other hand it might cause them to be confounded with the exostoses which I have called epiphyseal, following Cornil and Ranvier. Under the name *cartilaginous periosteal exostoses*, Sir Astley Cooper did not have in view exostoses of development alone; indeed, he gives this name to a bone-tumor occurring in a patient fifty years old.

Osteogenic exostoses arise in the portion of the diaphysis in which the bone increases in length, in the part of the bone called juxta-epiphyseal. They have, indeed, as Broca and Ollier have shown, this seat in common with inflammatory and neoplastic lesions in young subjects. The name epiphyseal exostosis should then be supplanted by the name juxta-epiphyseal exostosis. Under the influence of any form of irritation, an excessive activity of the connecting cartilage may, at some point of its circumference, give birth to an exostosis.

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[1] Traité de la Régénération des Os. Multiple exostoses are not rare; and under certain circumstances, as in the case of the patient referred to, it would seem as if the subjects were under the influence of a true osteogenic diathesis.

[2] Compendium de Chirurgie.

Seat, Size, Shape, etc.—These exostoses occupy the ends of the long bones, and especially the lower extremity of the femur (principally on the internal surface, above the condyle), the upper end of the humerus, the tibia, etc. They are met with on the pelvis, the scapula, the junction of the sphenoid and the basilar portion of the occipital bone. Usually these exostoses are small—the size of a cherry. Still, a number of larger ones have been reported, one of which attained the size of the head of an adult. According to Dr. Soulier, they are sometimes wart-like, sometimes tuberculated, sometimes in the form of an apophysis, or actually coracoid. They are often multiple, and may or may not be symmetrical. Symmetry is of real importance in the diagnosis of this variety. The course of exostoses of development is slow; they follow the development of the skeleton, and especially that of the bony extremity upon which they are situated.

Structure.—At an early period osteogenic exostoses are composed of, (1) a layer of periosteum; (2) a layer of cartilage; (3) bone-tissue apparently analogous to that of the bone itself. At a later period the cartilage has generally disappeared, the bone-tissue has become spongy in the centre, and sometimes it is hollowed out by a medullary cavity communicating with the medullary canal of the bone.

When the exostosis of development is situated on the diaphysis of the bone, it is the rule to see it recede from the articular extremity as the bone increases in length. This fact is sometimes noticed by the patient himself; it is more manifest as the exostosis has made its appearance at a period more remote from that of the cessation of growth. The same occurrence is not noticed when the exostosis is upon the epiphysis. Friction sometimes occasions the production, on the surface of these exostoses, of adventitious serous bursæ, which sometimes communicate with the synovial membranes of the neighboring joints.

Etiology.—The etiology of these exostoses is little understood. It seems that inheritance plays a certain part in some cases. Traumatism has been supposed to be concerned in their production, and pressure, fatigue, rheumatic periostitis (Virchow), and rachitis; but none of these causes is absolutely demonstrated. They are usually developed from the 11th to the 30th year.

Symptoms.—The beginning of these exostoses is usually insidious, and they are generally discovered by accident. Sometimes, however, slight pain or interference with certain movements, has been noticed. On exploration there is found a rounded tumor, generally a little mammillated, and well circumscribed. It is of a peculiar consistence, and of bony hardness. The adherence to the bone is absolute. On the contrary, the skin and the superficial tissues move freely, and have undergone no change. Painlessness is almost always complete. In their development, exostoses act upon the surrounding organs and may give rise to certain accidents. Thus there have been observed acute and chronic hygromata of the newly-formed serous bursæ which sometimes cover the tumors more or less completely. Compression of the neighboring nerves sometimes gives rise to extremely violent irradiating pains. Coote[1] operated upon an exostosis of the transverse process of the seventh cervical vertebra, in a patient 26 years old. The tumor had caused numbness, and pains in the hand, fingers, arm, and shoulder of the same side. I saw, in a woman 22 years old, a little exostosis the size of a pea, situated on the external surface and almost at the median part of the eighth right rib. This tumor was painful on being touched, and was accompanied by intercostal neuralgia. I practised ablation, and the pain disappeared entirely. Vessels like the subclavian artery, the femoral, or the popliteal, have undergone consecutive ulceration. The muscles are sometimes the seat of spasms and of contractures. Finally, certain exostoses determine complications on account of the particular region in which they are found. Their presence in the cavity of the pelvis is in some cases an obstacle to labor. An exostosis has been known to perforate the bladder, and to lead to the belief that a calculus was present. These tumors never return after removal.

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[1] Union médicale, 1861.

Diagnosis.—The age, the situation, the peculiar hardness, the exact limitation, and the profound immobility, are the signs which establish the diagnosis. I shall have to return to this point in studying other bone-tumors.

Symptomatic Exostoses.—I shall have but little to say about the varieties of symptomatic exostoses. They are usually eburnated. As to the early symptoms, they will vary according to the cause which has given rise to the tumor. The history, the osteocopic pains of syphilis, will play an important part in the diagnosis of the cause. When once the exostosis has been formed, its signs will be the same as those of osteogenic exostoses.

Treatment of Exostoses.—Medical treatment is applicable only to exostoses of syphilitic origin, and, even with them, often leads to but incomplete success. Vigo's mercurial plaster, and the iodide of potassium internally, constitute the basis of the treatment. Recourse must be had also, sometimes, to the mixed treatment. John Hunter formerly recommended phosphoric acid internally; but this agent has been abandoned like others of the same kind. Recourse must therefore be had to surgical treatment, but I must say at once that, because of the dangers which may attend its employment, only those exostoses should be attacked which cause interference with the functions of an organ, or complications sufficient to authorize intervention. In cases in which an operation is contra-indicated, we should confine ourselves to advising the avoidance of fatigue and knocks, and to affording protection of the diseased part, either by an apparatus or by the application of layers of wadding.

(1) *Ablation.*—The tissues over the exostosis are to be incised, and, when this is exposed, its base is to be attacked either with a saw, with a chisel, or with a gouge and mallet. If the exostosis is voluminous, it may be broken into quadrilateral fragments, by saw-cuts crossing each other at right angles. Twice I have practised ablation of exostoses of the lower end of the femur, which were coracoid in shape, and which interfered with walking. No ill consequences followed, and there was no return, as I was able to assure myself a year and two years afterwards.

(2) *Resection.*—This consists in ablation of the portion of bone upon which the exostosis is situated. This operation is especially applicable to the bones of the face.

(3) *Denudation.*—Delpech, of Montpellier, sought to provoke necrosis by laying bare an exostosis, either solely by means of the contact of the air, or by combining with this cauterizations. These methods are abandoned, and with good reason.

(4) For *pedunculated exostoses*, Follin has advised to break the pedicle without previous incision of the skin, preventing its consolidation by frequent motion, and afterwards to extract the fragment of bone which is then attached only to the soft parts. In a patient fifteen years old, I broke off a coracoid exostosis of the lower end of the femur in this way. After some days of immobilization, I was careful to move the fragment every day, so that union did not occur, and, the functional pain which had made inter-

vention necessary having disappeared, it was not necessary to have recourse to ablation of the fragment of bone, which was engrafted in the midst of the neighboring tissues. The danger of these different methods is in many cases the occurrence of consecutive osteomyelitis, but the employment of the antiseptic method has considerably modified the prognosis of these operations. In certain cases palliative procedures have been employed. Ledentu,[1] in a patient who had an exostosis of the femur, practised subcutaneous section of the vastus externus, and this operation put an end to a violent pain which was accompanied by contracture.

Fibromata of the Bones.

Fibromata, or fibrous tumors, of the bones are very rare, and many of them have been confounded with sarcomata. These tumors are made up anatomically of fasciculated fibrous tissue. They may be divided, according to their point of departure, into *periosteal* and *central*, according as they start in the periosteum or in the medullary tissue. The latter are by far the rarer.

Periosteal fibromata are seen on the bones of the face and of the cranium. Naso-pharyngeal polypi belong to this variety. Some of the tumors formerly grouped under the name of epulis were fibromata. Volkmann says that he has seen them upon the pelvis and upon the ribs. In regard to fibrous tumors of the pelvis, I will mention a peculiar variety of tumor of the pelvic cavity, and especially of the wall of the abdomen, of which I formerly saw several examples in the service of Professor Ollier, and for which I have thrice had occasion to practise ablation in my own service. These tumors, mentioned for the first time by Nélaton, are attached to the crest of the ilium, or to some point of the pelvic rim, by a longer or shorter pedicle coming from the periosteum. They are seen most frequently in women. They have no relation to the bone, or rather to the periosteum, except their starting-point, and should not be included in a description of fibromata of the bones.

Central fibromata have been described by Paget in the inferior maxilla, the walls of which they push apart until they end by perforating them, and thus come to protrude on the outside. They have been rarely observed in the epiphyses of the large long bones, in the phalanges, and in the vertebræ.

Fibromata often undergo certain transformations. They become calcified, rarely are they ossified, sometimes they undergo fatty degeneration, or become cystic. In some cases they exhibit great vascularity. Their possible transformation into sarcomata is still doubtful, although admitted by G. Weber and Ed. Schwartz.[2] At any rate, it is well not to irritate such neoplasms; and if, from the anatomical point of view, the transition between sarcoma and fibroma is already only in some sort a question of degree, it must not be lost sight of that from the clinical point of view every neoplasm is a step taken toward a more serious new formation.

These tumors are formed by an agglomeration of hard lobules, constituted individually of a tangle of concentric fibrils. (Cornil and Ranvier.) They always remain well separated from the neighboring tissues. They are seen most frequently in youth and adolescence. Their growth is more or less rapid, and they may attain a very large size. It is to be noticed that certain varieties of these tumors, those known under the name of naso-pharyngeal *polypi*, are an exception to this rule; and that the majority of surgeons now admit, with MM. Gosselin and Legouest, that they undergo a stage of arrest and even of retrogression, at the age of about twenty-five years.

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[1] Revue Mensuelle de Médecine et de Chirurgie, 1879.

[2] Ostéosarcomes des Membres. Paris, 1880.

These are benign tumors, and usually do not recur after complete ablation, never implicating the lymphatic glands, and not becoming generalized, but being susceptible of undergoing certain transformations. Thus, in a young patient operated upon a number of times by M. Ollier, according to his method, for a fibrous naso-pharyngeal polypus, the tumor, after a number of recurrences, underwent a telangiectatic, aneurismal transformation. On auscultting the corresponding cheek, a strong blowing sound was perceived. These neoplasms are grave only from their size, and from the symptoms which they determine on account of the regions in which they are found. (These symptoms are treated of in studying naso-pharyngeal polypi.[1])

The only rational treatment of bone-fibromata is extirpation.

MYXOMATA OF THE BONES.

Myxomata of the bones are very rare, and often the myxomatous tissue exists only in mixed tumors, especially in certain myxo-chondromata and myxo-sarcomata. Volkmann admits that myxomata of bone-tissue arise in the centres of the bones. Cornil and Ranvier consider them as periosteal, and as capable of bringing about absorption of the bone at their point of implantation, and thus of penetrating to the centre of the medullary canal. According to these authors, it is easy to confound this neoplastic mucous tissue with the gelatinous-looking medulla of the bones of cachectic patients. Pure myxoma of the bones is a soft tumor, easily broken up. It presents nodosities, composed of several lobes, and of trabeculæ belonging to the pre-existing tissue. The color is clear gray, whitish, or pink, and sometimes the gelatinous appearance is very marked. Virchow, who considers these tumors as starting from the medulla, says that they are for a time enveloped in a shell of bone, which afterward disappears. They are most frequently met with in the maxillæ. In such cases the growths are often mixed neoplasms, myxomatous chondromata. This was the case in a young man upon whom, in my service at the Croix-Rousse hospital, I practised resection of the right upper jaw, and found a chondroma the whole centre of which was mucous or colloid. The diagnosis of myxoma from chondroma and sarcoma is almost impossible in many cases. The absence of cutaneous ulceration and of glandular invasion, and the course of the affection, furnish, however, valuable diagnostic signs. Myxomata of the bones are benign tumors, which do not become generalized; but they have a great tendency to local recurrence.

LIPOMATA OF THE BONES.

There have been recorded a single case of lipoma in the femur, observed by Cornil and Ranvier, and two cases in the superior maxilla (Viard and Triquet). Upon these observations rests the belief in the existence of this variety of neoplasm. According to Virchow, these tumors are only exostoses containing a large quantity of fatty marrow.

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[1] See Vol. V. pp. 426 *et seq.*, *supra.*

CHONDROMATA OF THE BONES.

Chondromata are met with much oftener in bone-tissue than in any other structure. By the name of chondroma are designated tumors made up of more or less abnormal cartilaginous tissue. (Lücke.) It is proper to separate at once from chondromata certain cartilaginous productions which are formed only on pre-existing cartilages, and to which are given the name of *ecchondroses.* Chondroma, properly so called, is never developed at the expense of pre-existing cartilages. (Cornil and Ranvier.)

History.—Chondromata were first studied by Cruveilhier,[1] and afterward by Müller, in 1838. The works of Vogel, Lebert, Fichte, Paget, Virchow, and Dolbeau, have completed the study of these tumors. In more recent times I would mention the thesis of Walsdorf,[2] and that of A. Aubert.[3]

Pathological Anatomy.—The varieties of bone-chondromata exhibit the structure of the different varieties of cartilage described in man, and besides, there are sometimes found in them anastomosing cells, forming a tissue like that of the cephalic cartilage of cephalopods. Dr. Bonnet writes as follows on this subject:[4]—

> Stellate cells are often present in considerable numbers. It is not, indeed, frequent to find them buried in a fundamentally hyaline substance; but the true cartilaginous cells are themselves placed in such variable intercellular substances (hyaline, fibrillary, elastic, mucous), according to the different parts of a single neoplasm under observation, that it is permissible to consider the two forms, stellate and encapsulated, as almost equivalent. These two forms, in enchondroma, play the same part, and replace each other with the greatest ease. Besides, they are not the only forms seen in this kind of tumor. In it may be observed the indifferent embryonic cell, the stellate cell, the fibro-plastic body on the one hand; and, on the other, the whole series of cartilaginous cells, and that in one and the same enchondromatous production. At its appearance, the cartilage has the embryonic form; at a later period, a hyaline intercellular substance, soft or hard, is secreted between the cells; these increase in size, assuming different shapes, angular or discoid; this is fœtal cartilage. It is only in the adult stage of the cartilage that the fundamental substance is condensed in such a manner as to form a sort of wall with double contour, or capsule, which contains the true cartilaginous cell. Less well-defined forms than the encapsulated may be seen in fibrous and elastic cartilages. M. Ranvier has studied these forms in the cartilaginous tendons of birds, etc. The cartilaginous cells appear as rounded, or rather cylindrical, cellular bodies, arranged in rows between the parallel tendinous bundles, which may and should be considered as the intercellular substance of these bastard cartilages.

All these appearances under which the cell of normal cartilage may be seen, may be met with in the cellular element of enchondromatous tumors. An enchondroma is usually divided into lobules, which are separated by connective tissue. At the edges of the lobules and of the connective tissue, there are often seen embryonic elements, at the expense of which the formation of cartilage takes place. Among the cells near the connective-tissue bundles, a certain number are fusiform; further in toward the centre of the lobules, they are surrounded by a very delicate rudimentary capsule. They are clear, rounded, smaller than the capsules of adult cartilage, and embedded in a fibrillar or soft substance. Finally, the stellate form is very common; but the cartilaginous cells must not be confounded with the cells of myxomatous points which are still much more frequent. (Bonnet.) All those varieties to which have been given the names of hyaline chondromata, chondro-sarcomata (Virchow), chondro-fibromata, ossifying chondromata, and chondromata with ramifying cells, may be met with in chondromata of the bones, but usually there is a combination of different varieties.

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[1] Anatomie Pathologique du Corps Humain, tome ii. 34e livraison, pl. 4 et 5. Paris, 1828; Traité d'Anatomie Pathologique, tome iii. p. 779, et tome v. p. 106.

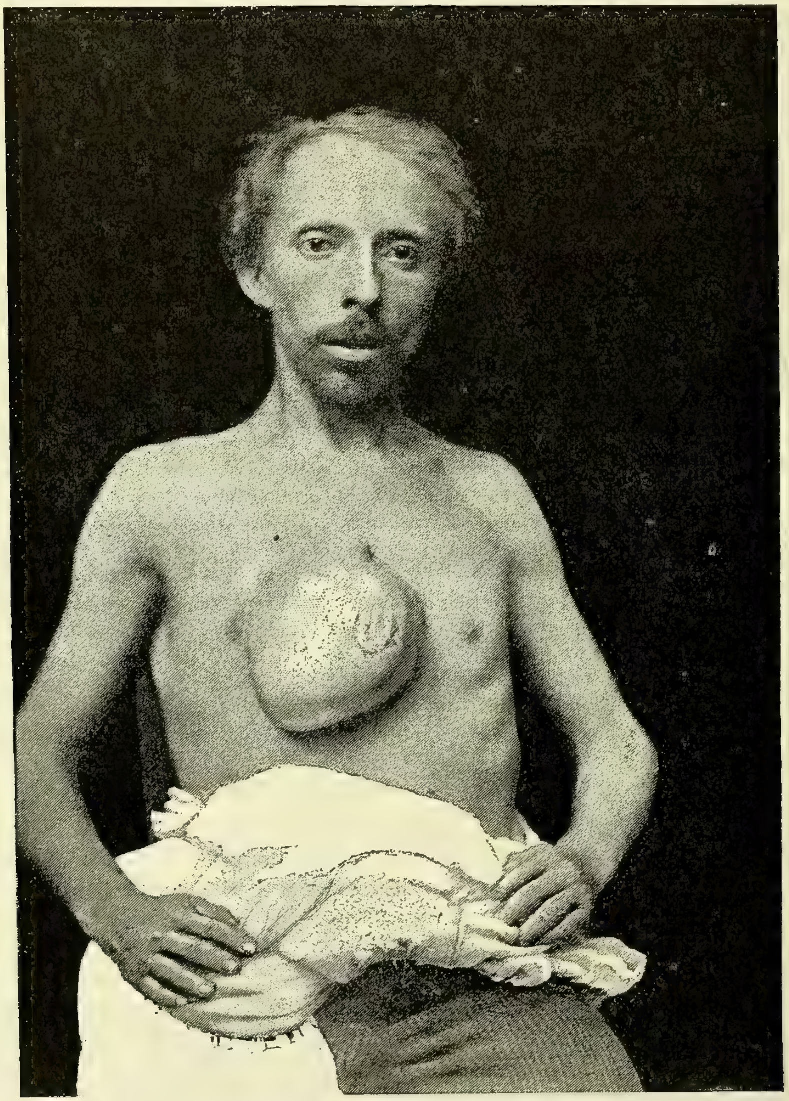
[2] Le chondrome malin. Paris, 1878.

[3] Thèse de Lyon, 1882.

[4] Thèse de Lyon, 1882.

Chondromata have been divided into perichondromata and enchondromata, according as they are developed on the exterior or in the interior of the bone. Nevertheless, the term enchondroma is often used in a general sense. Chondromata are usually seen on the small long bones of the hand, and more especially on the phalanges. They are very rare on the cranium. According to Dolbeau, the middle finger is more frequently affected than the other fingers. In the other bones, these tumors are developed preferably at the ends, in the juxta-epiphyseal portions. Chondromata are generally multiple.

Fig. 1464.



Cystic chondroma, with calcified nodules, situated on the anterior surface of the sternum, and encroaching on the corresponding costal cartilages. (Croix-Rousse Hospital, service of M. Poncet.)

Schuh mentions the case of a girl, twelve years old, who had chondromata on all the bones of the skeleton except those of the cranium and vertebral column. They are circumscribed or diffuse; but the latter form is rare. There are, however, often found small isolated nodules in the neighborhood of the large tumors.

Shape, Size, etc.—In *shape*, chondromata are usually spherical or oval. They are quite often composed of spherical lobules, which give them an irregular and bosselated appearance. They constitute, among neoplasms of the bones, the tumors which are capable of acquiring the largest *size*, varying from that of a nut to 2.15 metres (nearly seven feet) in circumference, as in the case of Sir Philip Crampton's patient.

Transformations.—Chondromata may be invaded by calcareous infiltration in the centres of the cartilaginous lobules. Fig. 0001 represents an enormous chondroma which occupied a part of the anterior surface of the sternum and of the neighboring costal cartilages. The cartilaginous tissue had undergone numerous transformations.

The patient was a man 45 years old, who came under my care in the Croix-Rousse hospital. The beginning of the tumor dated back to the age of 10 years. For several months past it had been developing rapidly; the skin was red and inflamed, and there was distinct fluctuation over a large part of the neoplasm. The substance was hard and resisting, being of the consistence of bone in some points. There was acute pain. Upon incision there was an abundant escape of sero-purulent fluid, and I found that I had to deal with a cystic chondroma, with calcified masses, a large part of which was necrosed and was easily detached. The implantation of the tumor upon the neighboring costal cartilages, and its deep connections, permitted only partial ablation, and as complete a scooping out as was possible without opening the mediastinum. The sequelæ of the operation were most simple; but three months afterwards large, fungating, sarcomatous masses had taken the place of the excised tissues.

True bone-formations have been met with in chondromata (ossifying chondromata). Sometimes the tumor is soft and fluctuating over a great part of its surface, and its contents are viscid, ropy, and of a colloid appearance. Cysts may be developed in chondromata, either under the influence of softening, or as a consequence of rupture of the bloodvessels.

Origin.—According to Cornil and Ranvier, chondromata arise from embryonic tissue formed by a process analogous to that of osteitis. According to Virchow, they arise in cartilaginous islets detached from the cartilage of ossification and remaining in the centre of the bone. (Heydenreich.)

Action on the neighboring Tissues.—The *skin* remains for a long time intact and does not give way until after extreme distention. The *bones* are thinned and eroded. The *fibrous tissues* are thinned and perforated. The *vessels* are rarely affected, though some observations seem to show that the cartilaginous substance may penetrate them. The neighboring *joints* are intact and not anchylosed.

Etiology of Chondromata.—Chondromata are most frequently seen in young persons. Some may even be congenital. Patients often refer them to traumatisms; this is a cause habitually mentioned, and one which should be taken into serious consideration, even if the traumatism acts only by producing a *locus minoris resistentiæ*. Rachitis and heredity have also been charged with the production of chondromata.

Symptoms.—The onset is generally slow and insidious. As to consistence, this varies according to the transformations undergone by the cartilage. When there are superficial cystic cavities it is not rare to find fluctuation. If the chondroma has started in the interior of the bone, it is surrounded by a shell of bone which becomes gradually thinned, and may give rise to the phenomenon of *parchment-like crackling*. A perichondroma, on the contrary, is enveloped only by the soft and fibrous tissues, which it pushes before it. In some cases, in which the tumor is very vascular, *pulsation* and a *blowing sound* have been discovered. Some tumors are actually *transparent.* This variety is most frequently met with in the fingers, which are so often the seat of multiple enchondromata. The hands often exhibit then several small tumors which resemble each other.

Course.—Ulceration of the integuments does not take place until very late, and when it happens it is the result of inflammation by distention. Partial gangrene of the mass has been observed. Finally, Chassaignac saw one of these tumors suppurate, and I can report also a case of this kind. Pain is a late feature, and is due to compression of the nerves. Chondromata are generally benign tumors, of slow course, sometimes remaining a long time stationary, but sometimes also making rapid advances. At the end of their evolution, when, by successive increase in their size, the skin is broken and suppuration is established, the patients may become cachectic and succumb. The duration of chondromata is often considerable. Such tumors may last ten years, sometimes even twenty years, before giving trouble.

I have said that chondromata can be classed with benign tumors. There are, however, malignant chondromata.[1] In some cases the lymphatics have been involved, and cartilaginous degeneration of the neighboring lymphatic glands has been observed. Visceral infection has also been noted: in the lungs by Bichet, Virchow, Volkmann, Baum, O. Weber, and Heurtaux; and in the spleen by Müller. It is well to remark that in these cases the growths were not chondro-sarcomata, but really true chondromata. Well circumscribed chondromata seem to be less grave than those which are the starting-point of tracks of embryonic tissue. (Heydenreich.) Local recurrence is quite frequent, but does not of itself indicate a malignant tumor. In such a case it is permissible to ask one's self if the operator has not left behind some morbid tissue. Further, it must be considered that, chondromata being multiple tumors, after ablation of a growth of this nature others may be developed in different parts of the skeleton, without there being necessarily a recurrence or generalization.

Diagnosis.—The diagnosis is easy in the hand or in the fingers; but much less simple in other regions. A firm and elastic tumor, large and with a bosselated surface, developed slowly, without pain, without enlargement of the lymphatic glands, without adhesion to the skin, and without cachexia, will suggest the thought of a chondroma. The presence of cysts will in some cases make an exploratory puncture possible, and the detection of cartilage-cells, with or without capsules, will furnish a valuable means of diagnosis. Spina ventosa bears a resemblance to chondroma only at first sight. Sarcoma and carcinoma are distinguished by their malignant course. Cysts of the bones may be more easily confounded with chondromata, as may fibromata; but the latter have generally a smoother and more regular surface.

Treatment.—Medical treatment is absolutely useless. As for certain palliative measures, such as partial ablation, or the opening of cysts which the tumor may contain, they are applicable only to special, well-defined cases. In cases of pedunculated enchondroma, section of the pedicle by the subcutaneous method has been of no service. Ablation is, then, the measure to be resorted to, and the particular operative procedure to be employed must be determined by circumstances.

(1) *Ablation.*—Formerly caustics were employed for the removal of chondromata, or for their destruction in place. But, with the employment of antiseptic dressings, there is now no reason for such a procedure, and prefer-

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[1] Walsdorf, op. cit.

ence should be given to the knife. The tumor must be removed freely, so as to prevent recurrence.

(2) *Enucleation.*—This procedure is applicable to enchondromata. Correctly speaking, the medullary canal is to be opened and scooped out through the whole extent in which it is believed that there is any morbid tissue. Dieffenbach seems, however, to think that morbid tissue left behind may become ossified and thus lead to a cure. This is the method recommended by Dr. A. Aubert[1] for certain chondromata of the fingers.

(3) *Resection.*—It may be necessary, in case of a central tumor, to resect the whole portion of bone affected with the degeneration.

(4) *Amputation.*—This is the last resource. It is not rare to see chondromata of the hand which are not of large size, which have no tendency to increase, and which allow the fingers to preserve the greater part of their functions. In such a case it is better to abstain from all surgical interference. Amputation would not be indicated except in case of rapid growth, or of great functional disturbance, when disarticulation should be practised at the next joint. For chondromata of the long bones, where the prognosis is often much more grave, the kind of amputation should be determined by the characters and extent of the neoplasm.

Pulsatile Tumors of Bone.

Sarcomata, at a certain stage of their development, may exhibit pulsation and a murmur under the influence of simple dilatation of the bloodvessels. These symptoms are observed especially in giant-celled and in round-celled sarcomata. (Gross.) The same phenomenon may be produced in carcinomata when the vascular element has increased considerably. This is a first variety of pulsatile tumor; but its study belongs to the history of sarcoma and carcinoma. At other times, in the midst of a tissue clearly sarcomatous or carcinomatous, there are found more or less anfractuous cavities, of different dimensions, containing blood and clots, and on the walls of which broken bloodvessels open. These cases constitute a second variety of pulsatile tumor, but their study also belongs to that of sarcoma and carcinoma. Finally, there are found in the bones vast cavities in which blood circulates, brought by vessels gaping in the wall, and containing also clots formed from the constituents of the blood. Their wall is made up of a fibrous web, without any trace of sarcomatous or carcinomatous tissue. In the cavity there sometimes float denuded vessels; the neighboring parts are simply distended and not altered. The dilated afferent vessels have healthy coats, just like the large vessels of the limb. This last variety of vascular tumor of bone has been the subject of an important paper by M. Richet.[2]

Synonyms.—Erectile tumors of the bones (Breschet). Hæmatomata of the bones (Volkmann). Aneurisms of the bones (Richet, Follin). We shall see that these different denominations correspond to different pathogenic theories.

Pathological Anatomy.—Pulsatile tumors of the bones are developed in the spongy tissue at the ends of the long bones, and especially at the upper end of the tibia. In the second place come the lower end of the femur and the upper end of the humerus. Demongeot de Confevron mentions a case occurring in the middle portion of the radius. The articular extremity is transformed into a shell, the irregular and anfractuous cavity of which has a constant tendency to increase. Sometimes the walls of the cavity are made up of bone-tissue reduced to the state of flexible lamellæ; sometimes the shell of bone is lacking at certain points, and is replaced by thickened periosteum. In Richet's case, the internal surface was covered by a reticulated fibrous layer, which Richet compares to the surface of a ribbed bladder. The tumor is single, its size is large, it may hold several litres of fluid. The contents are constantly pure blood, or blood which has undergone different transformations. The vessels are free from change ; injections thrown into the principal arteries fill the cavity. The neighboring articulations are healthy and appear sufficiently protected by the articular cartilage. There is no invasion of the surrounding soft parts.

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[1] Op. cit.

[2] Arch. Gén. de Méd., 1864.

Nature.—According to Breschet, these cases are comparable to those of erectile tumor. Nevertheless, there is found here nothing but an anfractuous cavity filled with liquid or coagulated blood, whilst erectile tumors are formed of a vascular tissue analogous to the cavernous tissue. The same remark is applicable to cirsoid aneurisms. Volkmann admits that the starting-point is the rupture of an artery, whether as the result of a traumatism, or in consequence of atheromatous degeneration of its walls. The case would then be one of false aneurism developed in a bone, but this hypothesis does not at all explain the opening of multiple vessels in the cavity of the tumor. Volkmann would suppose then, with Lebert and Rokitansky, that the sacs result from a telangiectatic transformation of a sarcomatous, and especially of a myeloplaxic tumor. If, on the one hand, it be admitted, as E. Nélaton has proved, that the myeloplaxic tumors are benign and may sometimes remain stationary; and, on the other hand, with MM. Monod and Malassez, that the myeloplaxic cells have a part in the formation of vessels, which has led them to call the myeloplaxic tumors *angeioplastic tumors*, it might be believed that interstitial hemorrhage had begun by pressing back the tissues of the tumor, and had then determined their atrophy. However, in the cases of Parisot and Richet, there was found only fibrous tissue without any trace of a tumor. It will be seen that there is still much to be desired in our knowledge of the pathological anatomy of this affection. Investigations of a number of points are still necessary in order to establish its nature.

Etiology.—Pulsatile tumors of the bones occur oftener in men than in women. They are seen in young patients and in adults. The influence of traumatism is noted positively in four cases out of nine.

Symptoms.—The appearance of the growth is sometimes preceded by pain; when there has been an injury, the disease may start suddenly with acute pain. The tumor forms but a slight elevation, but as it is developed the skin is sometimes seen to become reddened and to be streaked with dilated varicose veins. The consistence is variable; if, at the time of the examination, the tumor is limited by a wall of bone, the sensation called parchment-like crepitation may be felt. If the envelope is osteo-fibrous, there will be found some hard and some depressible points. In one case, the skin could be pushed into the cavity of the bone like the finger of a glove. Pulsation, isochronous with the pulse and accompanied by expansile motion, may appear either at the same time as the tumor, or a little later. These two symptoms disappear on compressing the principal artery of the limb. Fluctuation is perceptible only in tumors without a bony envelope. The blowing sound met with by Richet is not usually present. The *functional symptoms* are as follows: The joint next to the tumor has its movements partly abolished, without being always invaded by the lesion. There are pains in the limbs, caused by compression of the nerves. Painful œdema has also been seen, due to pressure upon the veins of the part. The *duration* of the disease is very variable. In published cases it has varied from three months to seven years.

Diagnosis.—An aneurism of bone may be confounded: (1) With an aneurism developed in the soft parts, without any lesion of the bone; (2) With one of the tumors of bone which exhibit pulsation; (3) With a simple bone-tumor. Aneurisms of the bones have symptoms analogous to those of aneurisms of the soft parts, and it is possible, therefore, to mistake one of these affections for the other. Nevertheless, it is generally easy to distinguish them by the following characteristics: Aneurism of the bone is connected with the subjacent bone; there are often found near its base lamellæ of bone which give the sensation of crepitation; by pressing down upon the tumor, it is noticed that the bone has undergone a loss of substance. Other aneurisms are movable, and but loosely connected with the bone near them; they may be displaced, and they have a much more marked blowing sound. The diagnosis from tumors accompanied by pulsation rests upon the following signs: (1) An aneurism in the bone disappears almost wholly under continuous pressure, while a sarcomatous or carcinomatous tumor is but little affected by pressure. (2) If the principal artery of the limb be compressed, turgescence and pulsation reappear much more quickly in purely vascular tumors. (3) Fluctuation, combined with pulsation and a murmur, constitutes, according to Professor Richet, a clinical sign of great value. In case there is an envelope of bone, an exploratory puncture, giving a jet of arterial blood, will enable one to make the diagnosis. (Jamain and Terrier.)

Prognosis.—These tumors are grave because they destroy the bone upon which they are situated, abolish the function of the limb, and necessitate ligation of the principal artery or amputation.

Treatment.—(1) Ligation of the principal artery of the limb has been employed in five cases, and has been followed by success four times (Lallemand, Roux, Lagout, Demongeot de Confevron); in the fifth case considerable improvement followed, but there was a recurrence after a fall on the knee (Carnochan).

(2) Amputation has been practised in three cases, with one death (Peterson), one recovery (Parisot), and one recurrence (Scarpa). A fourth patient, operated upon by Richet, had secondary hemorrhages which required ligature of the subclavian, the patient dying of pyæmia.

(3) Compression of the principal artery has failed in one case. It seems to me that this method of treatment ought always to be employed at first. After a methodical trial of it, one may think of further surgical interference. To sum up, in cases of pulsatile tumors of the bones, the surgeon should commence by compression of the principal vessel of the limb. If compression fails, he should try the ligature. Amputation should be practised only as a last resort. Electro-puncture, and the coagulating injections recommended by Volkmann, should be utterly rejected. I have given here a summary of the investigations of certain surgeons in regard to aneurisms of the bones, but I feel bound to say that this lesion is extremely rare, and that, in the great majority of cases, very vascular sarcomata have been mistaken for aneurisms—tumors which are truly aneurismal, and which present all the clinical signs of a dilatation situated in the course of a large vessel. In the museum of our Faculty of Medicine are found several specimens of this kind, collected by Marc-Antoine Petit, Gensoul, etc., and designated by the name of aneurism. These tumors required amputation of the limb, and from their anatomico-pathological characteristics it is evident that those surgeons had telangiectatic sarcomata to deal with.

Cysts of Bone.

E. Cruveilhier[1] has described cystic cavities which he considers the starting point of intra-osseous abscesses. Their study belongs with that of abscesses of the bones. The same is true of a certain number of tumors which eventually undergo cystic degeneration in some part of their substance. The most important variety of bone-cyst is of parasitic origin—I refer to the hydatid cyst. Finally, true cysts are met with. These last two varieties alone shall occupy us. As they differ only in their pathological anatomy and in their etiology, I shall describe both varieties together. I shall eliminate at the outset a whole variety of cysts which arise in the maxillary bones, and which are known by the names of *dental cysts*, *cysts of the periosteum*, *cysts of the roots*, *follicular cysts*, *dentiferous cysts.* I shall do the same with regard to cysts of the maxillary sinus, and those of the inferior maxilla, which sometimes contain, as Prof. Gosselin has remarked, serum and sero-sanguinolent fluid.

Pathological Anatomy.—Simple bone-cysts are unilocular or multilocular, but much more frequently multilocular. Their size varies. They may attain considerable dimensions, as in Nélaton's case, in which the tumor occupied the femur from the base of the great trochanter to a point two centimetres above the condyles. The internal wall is covered with a membrane having the smooth appearance of serous surfaces, and sometimes presenting fibroid vegetations. These cysts sometimes contain pure serum, sometimes sero-sanguinolent serum, sometimes a viscid liquid like a solution of gum. In multilocular cysts, delicate partitions separate the different cavities.

In almost all bone-cysts echinococci have been found, and in one the cysticercus cellulosus. The cyst itself shows nothing peculiar; it is constituted like all hydatid cysts; the bone occupied by the parasite is at first hollowed out into a cavity, which increases as the vesicle is developed. It becomes distended, and the shell of bone ends by being perforated, when the hydatid is covered only by the periosteum. Hydatids usually occur in the spongy tissue; sometimes however they are met with in the medullary canal. In a specimen which I examined some years ago at the Hôtel-Dieu, and which was derived from the practice of a physician in the country, I found several hydatids in the medullary canal of the tibia from a leg amputated the evening before at the point of election. I could not get any history of the case, but a marked hyperostosis, and fistulous tracks which appeared to be old, on the inner surface of the bone, attested the chronic character of the affection.

Situation.—Hydatids are met with in almost all the bones: tibia, humerus, femur, vertebræ, and iliac bones. A number of bones may be affected at the same time. In 1872, in the service of Dr. Léon Labbé, at the hospital of La Pitié, there was a patient who had a large hydatid cyst of the humerus and scapula. Simple cysts of the bones have been seen in the femur by Nélaton, in the humerus by Sir Astley Cooper and Monod, in the tibia by Sir Astley Cooper, in the ulna by Carle,[2] and in the scapula by Robert.

Nature.—The ideas which we have in regard to cysts [apart from hydatid cysts] of the bones are very incomplete. Volkmann considers them as metamorphoses of solid tumors. In reality there is no certainty on this subject.

Etiology.—Nothing is known relative to the etiology of true cysts. As for hydatid cysts of the bones, their etiology is the same as that of all hydatid cysts. Traumatism seems to play a certain part in their development.[3]

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[1] Sur une forme spéciale d'abcès des os. (Thèse.) Paris, 1865.

[2] Lyon Méd., 1878.

[3] Boncour, Thèse, 1878.

Symptoms.—These tumors generally develop without pain and without inflammation. The first symptom is swelling of the bone. This swelling is at first hard; afterwards parchment-like crackling can be perceived; finally, the shell of bone being destroyed, fluctuation may be noticed, and sometimes the hydatid fremitus. The symptoms observed in the neighboring parts vary according to the region affected. They are, speaking generally, the symptoms of compression. Spontaneous fractures often occur from the slightest cause. As a rule these fractures do not unite, and the diagnosis is established by operations undertaken for the cure of the pseudarthrosis. The neighboring joints may be involved. In some cases the cyst suppurates under the influence of a traumatism or of surgical intervention.

Diagnosis.—The diagnosis is almost impossible at all stages of the disease, and in the later periods it can only be established by exploratory puncture.

Treatment.—(1) *Puncture.*—Puncture, whether simple or combined with irritant injections, does not give satisfactory results.

(2) *Incision.*—This procedure consists in opening the cyst freely through its whole extent, emptying it entirely of its liquid and of all the hydatid sacs, and leaving to suppuration the work of cure. The contraction of the sac does not commence until after several weeks, and complete recovery may be delayed more than a year.

(3) *Resection.*—This consists either in gouging out the bone, if it is not invaded through its whole thickness, or in a true resection involving a greater or less length of the diaphysis. The subperiosteal method ought to be carried out as strictly as possible.

(4) *Amputation* is the last resource, in cases in which the cyst occupies too great an extent of the bone for the employment of milder measures.

SARCOMATA OF BONE.

History.—The tumors which are at the present day known as sarcomata of bone, have a history which may be divided into three periods. The first period is one of entire confusion. J. L. Petit and Sir Astley Cooper called them exostoses and carnifications. Sir Astley Cooper, however, classified them according to their point of origin, and divided them into *fungous medullary exostoses* and *fungous periosteal exostoses.* The word *osteosarcoma*, which appeared with Samuel Cooper, Boyer, and Richerand, was up to the time of Dupuytren synonymous with cancer of the bones, and it was again cancer of the bones which Bérard described.[1] Nélaton considered sarcoma of the bones as the second form of cancer; and the same is true of the authors of the Compendium. The second period is characterized by the preponderating influence of micrographic researches. Lebert studied the fibroplastic tumors, Robin the embryoplastic, and Paget the myeloid, which were analogous to the medulla of the bones, and which Robin divided into myeloplaxic and medullo-cellular tumors; Virchow restored all these tumors to the class of sarcomata. Finally, the third period is that in which an effort has been made to reconcile clinical experience and histological data. H. Gray, Robin, and E. Nélaton, seek to distinguish microscopically certain benign tumors which form the myeloplaxic or medullo-cellular class of myeloid tumors. This distinction is also accepted as well defined by MM. Verneuil and Marchand,[2] but some malignant cases have been recorded, and certain of these tumors include anatomical elements which connect them with the other sarcomata by insensible gradations; so that, while treating them as a separate group, I shall include them in the grand class of *sarcomata.* Virchow has added to the tumors already classified a variety formerly described by Müller—*osteoid tumors.* I shall devote a few words to them. Finally, I shall describe in a third group the *fasciculated*, and the *encephaloid sarcomata*, neoplasms which have often been thrown together under the name of *osteosarcomata.* We find them thus described by Schwartz.[1]

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[1] Dictionnaire en 30 volumes. Art. Ostéosarcome.

[2] Dict. Encyclopédique. Art. Moelle des os.

The sarcomata are situated on the long bones oftener than on the short bones, on the lower limb oftener than on the upper, on the bones near the trunk oftener than on bones remote from it, on the extremities oftener than on the body of the bone, and this because of physiological considerations to which I have already referred. Usually the disease begins as a single tumor, but under some circumstances several bones are attacked simultaneously, without there being any possible question of generalization. In a patient under my care, there appeared, at the same time with a sarcomatous tumor of the upper end of the fibula, a number of other tumors of the same nature on the cranium; these neoplasms were absolutely contemporaneous. The size of the original tumor is variable; it may reach a considerable development, and especially in young subjects. I have seen sarcomata of the femur six times the size of the thigh. In a case of Herrgott's, the limb could not have been put into a potato-bag. The consistence is variable in different tumors, and even in different parts of the same tumor. The sensation of crepitation is frequently perceived; this is sometimes the parchment-like crepitation, and sometimes a crepitation caused by the breaking of trabeculæ of bone, like the crackling of an egg-shell. This peculiar noise, which one does not forget when it has been once distinctly heard, is often of capital importance for diagnosis. The hard tumors push away the organs, distend them, separate them, and cause their atrophy. The soft tumors at first separate the tissues, but then permit themselves to be depressed and to receive the imprint of neighboring organs, in the form of depressions and grooves. The compression acts in different ways on different organs. Compression of the nerves gives rise to paralysis of the innervated territory, to neuritis, and to trophic disturbances. The arteries are rarely destroyed, and remain permeable, though surrounded by the tumor. The veins are flattened, obliterated, and invaded by sarcomatous outgrowths, which protrude from their internal wall and may become the starting-point of emboli. The aponeuroses are thinned, and afterwards perforated. The distended skin becomes frayed, and sloughs, when the tumor has attained a considerable size.

MYELOID TUMORS.—*Synonyms:* Medullo-cellular and myeloplaxic tumors; central or myelogenic sarcomata.

Pathological Anatomy.—The maxillæ are the bones oftenest affected, then come the parts of the skeleton supplied with red marrow, the epiphyses of the large bones, the sternum, the bodies of the vertebræ, etc. M. Ollier[2] found seven myeloid tumors of the upper jaw made up of myeloplaxes; once also the lower jaw, the vertebral column, one of the parietal bones, the tibia, and the phalanx of the index were affected with myeloplaxic myeloid tumors, twice the femur was invaded, and in two other cases the same bone presented a tumor with medullo-cells. In a general way these tumors have a double origin: they may be peri-osseal or intra-medullary, that is to say, periosteal or central. *Periosteal* neoplasms have been rejected by Vichow in fibro-plastic sarcomata and in osteoid sarcomata. According to other authors, these tumors are a transition stage between benign and malignant growths. Verneuil and Marchand consider them as belonging clearly to myeloid tumors. They rest upon the bone, with which they have cellulo-vascular attachments. The bone-tissue at their seat may show only superficial erosions, but sometimes the depression penetrates to the medullary canal. *Intra-osseal* tumors are by far the most frequent. They are encysted or diffused. In the encysted form, in proportion as the bone is destroyed by the encroachments of the tumor, a sub-periosteal new formation forms a more or less thick shell of bone around it. When this shell is wanting at any part, the wall of the cyst is osteo-fibrous. In the diffuse form, neoplastic masses of variable size are spread through the much enlarged areolæ of the bone. The bone then acquires a peculiar cavernous appearance. Vascularization is very abundant, and interstitial hemorrhages, by filling the areolæ with blood, produce a resemblance to aneurism. Nélaton has spoken of a form called perforating, which is remarkable for the rapidity with which central tumors perforate the bone and spread outside of it.

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[1] Ostéosarcomes des membres. (Thèse d'agrégation.) Paris, 1880.

[2] Thèse. Montpellier, 1855.

The neighboring tissues—aponeuroses, muscles, tendons, vessels, and nerves —are pressed backwards and asunder, and hollow out for themselves depressions and grooves in the neoplasm without being involved in the degeneration. The cartilages oppose an almost insuperable barrier to invasion, and, in order to penetrate to the joints, the neoplasm goes around them. E. Nélaton has spoken of two varieties of myeloid tumor: one in the crude state, the other in the state of softening. Sub-periosteal myeloid tumors have a firm and resistant consistence, such as is rarely presented by intra-osseal tumors. The tissue in the intra-osseal form is at first firm, elastic, and quite coherent, but is at a later period transformed by softening into a substance without more cohesion than the substance of the brain. When in this stage hemorrhages occur, they transform the morbid growth into a brownish mass which might be mistaken for clots. Tumors composed of myeloplaxes have on section a red, or reddish-brown, color. Those which are made of medullo-cells have a yellowish-gray tinge.

Histological Structure.—Myeloplaxes and medullo-cells are the fundamental element of these tumors. In such neoplasms they have the same form as in the medulla, but often their size is larger. Fibrous trabeculæ traverse the tumor, and form a sort of reticulum, in the meshes of which the myeloid cells rest. But this fibrous tissue is only accessory, and its greater or less quantity modifies the consistence of the tumor. In the centre of the mass there is often found a trabecular network of perfect bone-tissue. (Verneuil and Marchand.) These tumors present multiple degenerations: fatty, cystic, telangiectatic. Cavities are found in them, filled with blood from interstitial hemorrhages; and masses of bone, which have sometimes led to their being considered as ossifying tumors.

Etiology.—Myeloid tumors are usually developed below the age of thirty years, and oftener in men than in women. Traumatism has been noted as a predisposing cause, as well as repeated irritations of one point of the skeleton.

Symptoms.—These tumors are developed either in the mouth, inside or outside of the dental arches, or—but much more rarely—in an epiphysis or even a diaphysis of a long bone. They are adherent to the bone, and are not movable at any period of their evolution. Peri-osseal myeloid tumors are hard and firm. No notion can be formed of the consistence of intra-osseal tumors until they have perforated the compact substance; a little before which occurrence, parchment-like crepitation may sometimes be perceived, even on light pressure. The consistence varies also with the points examined; there are few tumors which exhibit differences of consistence in different points in so distinct a manner. These tumors are often the seat of pulsation, of expansile motion, and even of a murmur. Their complications are: plastic arthritis due to proximity, spontaneous fractures, distortions of the joints, etc. (Terrier.) The first stage of development of these growths usually passes unnoticed. Sometimes they are first observed after a traumatism, which may, moreover, provoke rapid evolution of a tumor which up to that time had been slowly developed. These tumors are usually painless, except in cases with a rapid course. The health and constitution of the patients remain a long time unaffected. Verneuil thinks that these tumors do not invade the lymphatic glands; in a case of Ollier's, however, the glands were implicated. The size of the mass, ulceration of the skin from stretching, consecutive suppuration, interstitial hemorrhages, and pain, end by exhausting the patient.

Diagnosis.—The diagnosis is not always easy. An exploratory puncture generally gives exit to a few drops of blood, a thing which does not occur upon puncture of a fibroma or chondroma. Central tumors cannot be diagnosticated with certainty at the outset. The absence of glandular engorgement, and the integrity of the general health, may lead to a thought of these tumors.

Prognosis.—Myeloid tumors are benign, but perhaps less so than E. Nélaton seems to think. There are, in fact, rapid and malignant cases—quite rare according to Verneuil, but quite frequent according to Virchow, especially when the affection is seated in the bones of the limbs.

Treatment.—(1) *Ligation of the Artery of the Limb.*—This operation was done by Dupuytren in a case in which there was pulsation, and it gave a good result for seven years, when recurrence took place, making amputation necessary. I only mention this case, which probably rests upon an inexact diagnosis. (2) *Simple Excision.*—Excision, which has been employed especially for periosteal tumors, is an incomplete operation, to which cauterization or scraping of the surface of the bone must be added. (3) *Excision of the Tumor and Ablation of a portion of the Bone.*—In this, ablation of the tumor is followed by scooping out of the bone with the gouge and mallet, through the whole extent which may be supposed to be affected. (4) *Partial or total resection* is especially applicable to the maxillæ. (5) *Amputation*, or better, *disarticulation*, is the procedure especially applicable to the bones of the limbs.

After having described myeloid tumors, I cannot pass over in silence a variety of growth described by Dr. Bouveret,[1] which he has called *osteoblastic tumor.* This is a neoplasm composed essentially of the elements which are met with in bone-marrow; but by its generalization this tumor is assimilated to tumors of greater malignity.

The sarcomata which I am next about to describe are of two varieties, when regarded from the standpoint of pathological anatomy. Their symptoms closely resemble those of some tumors of which I have spoken already. I shall consider them especially in regard to their malignity.

FASCICULATED SARCOMATA.—*Synonyms:* Fibro-plastic tumors; spindle-celled sarcomata; recurrent fibroids (Paget); fibro-nuclear sarcomata (Bennet). *Situation.*—These neoplasms are met with especially at the ends of the bones, but sometimes also in the diaphysis. They are situated preferably in the long bones, as in the lower end of the femur or the upper end of the tibia; but they are also seen in bones of the cranium, of the face, of the tarsus, etc. Their size is often considerable; their shape is rounded or oval; they are smooth, and rarely bosselated. Their starting-point may be the periosteum or the centre of the bone. Central tumors have a bony, or an osteo-fibrous shell, which is wanting in periosteal tumors, in which there is from the first only a fibrous shell furnished by the periosteum, which is usually consecutively involved. The consistence of these tumors is usually firm and elastic. They creak under the blade of the knife. On section, the surface appears smooth and shining. The color is light gray in some places, and rosy at others, and extravasations of blood are sometimes seen.

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[1] Thèse de Paris, 1878.

When one of these tumors is left for some time exposed to the air, a little milky juice can be obtained by scraping. It is not unusual to find in the tumor bony trabeculæ, radiating or in the form of needles.

Microscopical Examination.—These tumors are made up of longer or shorter fusiform cells; those with small cells are the softest. Myeloplaxes are found in them, as accessory elements. They undergo cystic degeneration more rarely than other neoplasms, and are but slightly vascular.

ENCEPHALOID SARCOMATA.—*Synonyms:* Round-celled sarcomata; embryoplastic tumors; globo-cellular sarcomata; granulation-tissue sarcomata (Billroth). *Situation.*—Encephaloid sarcomata are situated in the extremities of the long bones, in the short bones of the foot and of the hand, and oftener than the fasciculated sarcomata in the diaphyses of the large long bones. Their shape is globular; they are smooth; those which are developed at the expense of the central canal have an enveloping capsule, partly bony and partly fibrous; those which arise in the periosteum have a fibrous capsule which is soon invaded. When these tumors are cut, the surface of the section presents an appearance which has been likened to the milt of fish, or to the cerebral substance. Exposure to the air makes it possible to collect on the surface a much more abundant juice than in the case of the preceding tumors.

Microscopical Examination.—The fundamental element is the round, embryonic cell, the size of the white corpuscles of the blood. As accessory elements we meet with connective tissue of the ordinary kind, or reticulated tissue—which has led Rindfleisch to give this variety the name of the lymphadenoid form—or a very vascular tissue determining a form called alveolar by Billroth. These tumors often undergo cystic and telangiectatic degeneration, and are the seat of interstitial hemorrhages. I shall now enter upon the study of conditions common to all the sarcomata.

Condition of the Neighboring Articulations.—Gillette considered integrity of the joints as nearly constant, and as constituting a good diagnostic sign. Dr. Poinsot, who agrees in this with S. W. Gross, of Philadelphia, opposed this assertion at the Society of Surgery. The joints are affected in some cases, and more frequently by central than by periosteal sarcomata. At the beginning there are found more or less sanguinolent effusions. The cartilage resists a long time, but sometimes it is perforated. At other times it is detached in its totality, and the neoplasm, penetrating the peripheral parts, pushes outgrowths into the interior of the joints. In some cases both articular extremities are involved.

Spontaneous Fractures.—Spontaneous fractures often occur in cases of osteosarcoma of the long bones. Two cases may present themselves: 1. The bone has already been invaded by a periosteal sarcoma, and the two fractured extremities are lost in the midst of the mass of the neoplasm; 2. A central sarcoma has rarefied the bone, a fracture has taken place, and at the end of a few days a sort of expansion of the neoplasm occurs between the fragments, which expansion may be mistaken for callus in the process of formation. These fractures very rarely consolidate; sometimes, however, callus may be formed, but it rarely comes to completion. The limb is removed, or the patient dies beforehand of cachexia. The embryo-plastic sarcoma appears to predispose to this more than do the other forms.

Generalization of Bone-Sarcomata.—Sarcomata of the bones first invade the whole of the bone in which they are situated. This invasion takes place very rapidly in central sarcomata. In periosteal sarcomata, it is necessary that the tumor shall have first penetrated to the medullary canal. The tumor may extend to the neighboring bones, especially in fasciculated sarcoma. This fact is important in regard to operations. Involvement of the lymphatic glands is occasionally seen. Finally, visceral generalization is extremely common, especially in the fasciculated periosteal sarcoma, which has led S. W. Gross to say that spindle-celled periosteal sarcomata become generalized in almost all cases.

Etiology of Bone-Sarcomata.—The causes of sarcomata of the bones are not well understood. Their occurrence has been noted at the seat of an old fracture, or an old sprain, or after a traumatism. This explanation of their etiology has been considered unworthy of attention by many surgeons, but I do not share such a way of thinking. It is certain that many cancerous tumors appear without appreciable cause in patients having a predisposition to such a development; but it is not less true, if account be taken of the history given by the patients, that traumatism has often been the starting-point of a sarcoma. I have often met with such a cause, and I confess that I cannot comprehend why violence capable of producing inflammatory lesions in the contused bones, may not, in predisposed subjects, play the part of a determining cause in the development of neoplasms. These tumors appear between the ages of 20 and 40 years, but especially before that of 30 years. They are, according to Schwartz, twice as frequent among men as among women.

Symptoms of Bone-Sarcomata.—(1) *Stage of Onset.*—The onset varies with each case. In the greater number of cases attention is attracted by pain at some point, dull, intermittent, increased by fatigue, sometimes rheumatic or neuralgic in character, and acute enough to prevent sleep. In other cases the appearance of an indolent tumor precedes the pains. Finally, in some cases the pains and the tumor appear simultaneously. Central sarcomata are said to be more painful than periosteal; and sarcomata of the diaphyses to be more painful than those of the epiphyses. In some cases a spontaneous fracture is the initial phenomenon.

(2) *Stage of Full Development.*—The symptoms of this stage may be divided into three groups: (*a*) common symptoms, independent of the seat of the tumor; (*b*) symptoms depending on the proximity of a joint; (*c*) symptoms peculiar to a tumor of the diaphysis.

(*a*) *Common Symptoms.*—There is a swelling which is continuous with the bone, and the base of which it is always necessary to examine, as the tumor may have mobile prolongations. The integuments, which are generally healthy, are stretched, but of normal color, and they do not ulcerate until late. In about a third of the cases, dilated veins are seen. The muscles of the affected region are atrophied. Tumors of central origin often present, during some period of their evolution, parchment-like crepitation. Fluctuation may be met with in soft tumors, or in those affected by cystic degeneration. In some cases pulsation and a blowing sound have been noticed. The local temperature may be slightly elevated. This local rise of temperature is sometimes quite marked, and is proportioned to the more or less rapid development of the tumor. At the beginning, the general health is most often good. Sometimes slight emaciation is noticed, and a peculiar fever, called sarcomatous. (Verneuil.)

(*b*) *Symptoms depending on the Proximity of a Joint.*—The swelling assumes a peculiar shape which has been compared to that of an enormous leg of mutton. The limb, or the limb-segment, is in a position analogous to that which is assumed in cases of arthritis. There is a greater freedom of movement than would, at first thought, be supposed. It is important, however, to be careful not to confound movements of the joint with those which might result from a fracture near the articulation.

(*c*) *Symptoms peculiar to a Tumor of the Diaphysis.*—The shape of the tumor may be globular, if the tumor is lateral; fusiform, if the tumor has involved the whole circumference of the diaphysis; club-shaped, if the tumor is near the epiphysis. In a patient fifteen years old, on whom I practised, at the Croix-Rousse Hospital, disarticulation of the left thigh for sarcoma of the diaphysis, the whole shaft was involved and was transformed into an enormous sarcomatous mass. On section, the two connecting cartilages were seen to constitute a barrier above and below. The consistence is hard to estimate on account of the layers of muscles. The neighboring joints are completely free. If the tumor is situated in a part of a limb containing two bones, the unaffected bone may be pushed aside, luxated, or consecutively implicated.

(3) *Stage of Cachexia and Infection.*—It is to be noticed that this stage usually coincides with that of ulceration. Elevations are formed upon the tumor; the distended skin becomes adherent, thinned, and assumes a purple color. A slough forms, ulceration succeeds this, and sarcomatous excrescences protrude. At this time various hemorrhages may supervene, either from the ulceration of the skin, or from the sarcomatous excrescences. Fever is lighted up, and the patient rapidly grows weak under the influence of septicæmic complications. In extremely rare cases, abscesses have been seen to develop in the neighborhood. Then emaciation comes on, and the patient has an earthy, sub-icteric complexion, and dies. Death may occur from hectic, from hemorrhage, from septicæmia, or from generalization of the affection. Generalization is especially apt to occur in the lungs, and this occurrence is sometimes revealed by hæmoptysis, but often nothing would lead one to suspect it. These latent pulmonary lesions are sometimes hastened by operations undertaken for the removal of the tumor. When secondary masses are present in other organs, peculiar symptoms will be found according to the organ involved. Recurrence after operation may take place: in the operation-wound, in the cicatrix after healing of the wound, at a point higher up the limb, or in internal organs. The latter is not a recurrence but a generalization. Lymphatic involvement of a sarcomatous nature is said to be rare. Some surgeons even find in this absence of adenopathy a sign by which sarcomata may be diagnosticated from other varieties of malignant tumor. The observation is correct; but the fact must not be lost sight of, that, when the skin is involved by the neoplasm, and ulcerated, swelling of the lymphatic glands is the rule.

Course of Bone-Sarcomata.—Sarcomata of the periosteum seem to progress by interrupted stages; central sarcomata have a more continuous course. The duration of life, without surgical operation, has varied from two to forty-six months. The most malignant tumors seem to be the encephaloid. Melanotic sarcomata of the bones are usually seen in the stage of secondary cancer, from generalization; but in some cases the bone-tissue is invaded by continuity. Thus, in an old woman on whom I practised disarticulation at the ankle-joint for a melanotic sarcoma of the foot, the starting-point of which was the skin on the dorsum, the greater part of the bones of the tarsus were infiltrated with melanotic nodules.

Diagnosis.—*Fibroma* of the bones is rare. Its slow course and hard consistence may make its presence probable, but not certain. *Chondroma* has nodes and bosses; it is often situated on the fingers, does not infect the lymphatic glands or the viscera, and has a slow and benign course. *Cysts* may be recognized by exploratory puncture. *Carcinoma* develops very rapidly, but a diagnosis cannot always be made, unless one can find on the patient other tumors of the same nature. *Osteo-sarcoma* may be diagnosticated by taking into account the course of the affection, its manner of development, and the characteristics of the tumor. A valuable sign, when it can be perceived with the fingers, is the bony crepitation of which I have already spoken.

Treatment.—The only rational treatment is ablation, whenever it is possible. But it is necessary to remove absolutely all of the new growth. Every sarcoma has a local and benign stage, says Schwartz. It is advisable therefore to operate as soon as possible. If there are enlarged lymphatic glands, they should be removed; if their removal is not possible, one may hesitate to interfere, since the operation will necessarily be an imperfect one. Generalization, whether visceral or osseous, contra-indicates operation. One may, however, be induced to interfere if the principal tumor be easy to operate upon, or if it be the seat of grave symptoms, whilst the secondary tumors do not immediately threaten life. In a child six years old, afflicted with an enormous ulcerated sarcoma of the right femur, a painful tumor and the seat of repeated uncontrollable hemorrhages, I did not hesitate, in spite of large lymphatic glands in the groin, to practise amputation in the middle of the thigh. By means of the antiseptic method I secured complete union by the first intention. Three weeks afterward, the child could not be recognized; his general condition had become excellent; he laughed, and played upon his bed. He died five months afterwards, carried off by visceral generalization. Is it permissible to amputate in the continuity of the affected bone? This question can be answered in the affirmative in cases in which there are well-circumscribed, benign tumors, and sometimes also when the tumor is situated in the femur, since disarticulation at the hip-joint is too grave an operation for one not to hesitate to practise it at the outset. Nevertheless, in the majority of cases recourse should be had to remote disarticulation. Resection is applicable to benign tumors alone. Ligation of the large arterial trunks has seemed to succeed two or three times.; but it ought not to inspire any confidence.

OSTEOID TUMORS.

The name of osteoid tumors is applied by authors to tumors of very diverse nature; and this confusion of terms is the cause of much obscurity. (Heydenreich.) Müller, in 1843, was the first to study them, and he considered them as malignant. Lebert, in 1845, classed them with homologous tumors, and looked upon them as benign. Stanley insisted on their malignancy. Virchow, studying the development of the bones, found in the bones of rachitic children a tissue which he called osteoid, and which he erroneously considered to be bone-tissue in the process of physiological formation, but which is peculiar to rachitic bones. Osteoid tumors will, in these pages, be regarded as neoplasms formed of the osteoid tissue of Virchow.

The following are the terms in which Cornil and Ranvier describe these growths: "An osteoid tumor is made up of trabeculæ of different form and dimensions, composed of a homogeneous or obscurely fibrillated refractive substance, often infiltrated with calcareous granules, containing angular corpuscles. The trabeculæ are separated by fibrous tissue in which the vessels run." "There are almost always scattered through them islets of cartilage which are developed in the fibrous tissue between the trabeculæ (osteoid chondromata)." "Calcareous infiltration in some part of these tumors is almost the rule. Isolated granules are deposited in the fundamental substance of the trabeculæ, but the corpuscles surrounded by this deposit do not thereby become bone-corpuscles. These corpuscles never exhibit any other than incomplete prolongations, and in small number. The fundamental substance never becomes lamellar." "These tumors are formed of a single mass, or if they are lobulated, they never show this disposition in as marked a degree as do ordinary chondromata."

Examination of these tumors with the naked eye does not reveal any characteristic signs. It is only by the microscope that their anatomical diagnosis can be made. Osteoid tumors arise most frequently under the periosteum. They surround the bone and adhere to it. The cortical substance may contain cavities, or may be perforated; but it is always possible to find the old bone in the tumor. The periosteum is pushed back, and afterwards destroyed, and finally the neighboring parts disappear in their turn. Osteoid tumors are situated on the long bones, especially on the femur and the tibia. They sometimes attain enormous dimensions. Their hardness is very marked, their surface is smooth and has only slight rugosities. There is little tendency to ulceration. The age of the patients varies from seventeen to fifty-five years. (Heydenreich.) The course of these tumors is that of malignant growths; they invade the soft parts and the adjacent bones. Osteoid tumors recur in their original position, and become generalized. Metastatic growths are often situated in the lung. A clinical diagnosis is impossible; it can only be said that the tumor is a malignant one. The treatment consists in ablation, if this be possible. When a limb is affected, amputation should be practised above the affected bone.

LYMPHADENOMATA OF BONE.

Lymphadenomata of bone are findings of the dissecting-room. They are usually secondary growths in patients affected with generalized lymphatic tumors.

EPITHELIOMATA OF BONE.

Primary epithelioma of the bones is rare, while secondary epithelioma resulting from propagation of a primary cancerous lesion of the soft parts is relatively frequent. Classical authors do not speak of primary epithelioma of the bone-tissue; and the only complete observation of an affection of this kind has been published by M. Cornil.[1]

My attention was called for the first time to cases of this sort by M. Ollier, who, in his long clinical experience, has had opportunity to see several examples of the kind. In all cases the patients are somewhat aged, usually between fifty and sixty years, or more, and have been affected in their adolescence with more or less acute juxta-epiphyseal osteitis of a long bone. These inflammatory affections are accompanied by necrosis of the bone-tissue, by abscesses which leave behind them one or more fistulous tracks, which sequestra or fungosities keep open for years. Many a time have I seen patients who have had fistulæ for twenty or thirty years, and in one case the fistulous track had lasted for fifty-one years. Under the influence of causes more or less well defined, but of which the age of the patient must form an important part, an inflammatory irritation continues without cessation; the local phenomena are modified, and a cancroidal, intra-osseous transformation occurs. The mechanism is certainly the same as in the cancroidal degenerations of old ulcers of the tongue, and of old ulcers of the leg or other part (cancroid following old issues), so that theoretically bone-tissue ought not to be primarily the seat of an epithelioma. The objection indeed is only apparent, since it may be admitted, in fact, that the transformation begins in the skin, more or less depressed and invaginated at the bottom of the sinuses; that the medulla and the bone-tissue are affected secondarily; and that it is especially on account of the structure of the medullary tissue that rapid infection follows. I am the more willing to admit this view, because, in a patient seen in my hospital service, and in whom there was a primary epithelioma of the left femur, with old fistulous tracks, the skin surrounding one of these was manifestly the seat of epitheliomatous granulations, over a space the size of a franc-piece. I examined some of these granulations microscopically, and they belonged to the variety called lobulated epithelioma.

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[1] Journal d'Anatomie (Robin).

In such cases the pains are sometimes quite severe, and the bone appears to be the seat of hyperostosis; it may even acquire a considerable size, but the shape of the hyperostosis, and especially the history, do not admit of the supposition that the tumor is an osteosarcoma.

The constant sign is the escape of a more or less abundant, sanious, fetid liquid. The fetor of the excreted products is extreme; they have the peculiar odor of the secretions of epithelial cancer. But it seems that, from the fact that the lesion is situated in a cavity accessible to the air, as is also the case in cancers of the orifices and of the natural passages of the body, they acquire a peculiar degree of fetor. It is first by the odor, as M. Ollier has justly pointed out, that the diagnosis is established. In some autopsies that surgeon found the medulla of a whitish-yellow hue, transformed into a veritable sebaceous material, and with a certain consistence which made it comparable to a stick of wax. Any of the bones may be affected with primary epithelioma. M. Levrat, an *agrégé* of the Faculty of Medicine, has reported to me the case of a patient in whom the calcaneum was the seat of a primary epithelioma. There was an opening in the skin on the outer side as large as a fifty-*centime* piece, leading into a vast cavity in the bone. There was a flow of sanious and fetid liquid (a fetor *sui generis*) from this orifice. The patient had been treated up to that time for osteitis. She declared that the affection had begun in the deep tissues. Esmarch and Nicoladoni have also reported cases of epithelioma developed in the cloacæ of necrosis.

The prognosis is extremely grave. On account of the diffuse character of the lesions, if the surgeon can interfere in time, disarticulation should be preferred to amputation in the continuity.

In a man forty years old, who had been subjected a year before by Professor Desgranges to amputation for an epithelioma of the leg following an ulcer, the amputation being done at the point of election, there was a recurrence after a few months. When I saw the patient, who had entered my wards in the hospital, the tumor reached up to the knee-joint, and there were extremely acute pains in the stump, probably from epithelial infiltration and compression of the sciatic nerve. As the patient was already cachectic, and had enlargement of the lymphatic glands of the groin, I did not think it right to practise disarticulation at the hip-joint, but amputation in the middle of the thigh. There was recurrence in the wound by the time it had cicatrized, and the patient succumbed some months after the operation.

Secondary epithelioma occurs especially in the face and in the legs. In the former situation, it necessitates as radical an ablation of all the diseased parts as is possible. In the lower limb, the question is between amputation of the thigh and disarticulation of the knee-joint. With modern antiseptic procedures, I prefer the latter operation, which gives much the better result from a functional point of view. Epitheliomata of the bones, whether primary or secondary, are rarely accompanied by generalization, though they very frequently give rise to enlargements of the lymphatic glands. But when the tumor is intra-medullary from the beginning, as in primary cancroid, it soon causes cachexia, very probable because of the development of the affection in a tissue as vascular as the marrow of bone.

CARCINOMATA OF BONE.

Although the majority of the malignant tumors described by the ancients under the name of cancer of bone, belong to the class of sarcomata, nevertheless a certain number are primary carcinomata. (Volkmann, Cornil and Ranvier.) Most often, carcinomata of the bones are secondary, whether they result from the propagation to the bone-tissue of carcinomatous products of the soft parts, or whether they are deposited in the bones as the result of generalization of primary carcinoma of the soft parts or of the viscera. (Jamain and Terrier.)

Pathological Anatomy.—The commonest form of carcinoma of the bones is the encephaloid, which often exhibits great vascular richness. Primary carcinoma, which occurs especially in the bones of the face, cranium, vertebral column, and pelvis, in the epiphyses of the large long bones, and finally in the sternum, is seen in two distinct forms—the circumscribed, and the infiltrated or diffuse. The circumscribed variety appears in the form of bosselated masses, of variable consistence, pretty well limited, and sometimes covered with a true fibrous capsule, sometimes with a very fragile shell of bone, which is never present except at the beginning. When the carcinoma is infiltrated or diffuse, it is seen in masses scattered through the medulla, either of the diaphysis or of the epiphysis. This form, which has been studied and described by Forster, attacks a large number of bones at the same time, and generally starts in the vertebræ. The bone-tissue, destroyed by the neoplasm, loses all power of resistance. Accordingly fractures are seen to occur, or rather deformities analogous to those of osteomalacia, whence this variety has received the name of carcinomatous osteomalacia. (Forster, Volkmann.) Secondary carcinoma is usually met with after cancer of the testicle, of the uterus, or of the breast. It may be situated in the majority of the bones, especially in the spinal column, in the cranium, and in the pelvis. (Follin, R. Volkmann.)

Etiology.—Carcinoma of bone seems to occur almost equally in the two sexes, although secondary carcinoma of the vertebral column, which ordinarily follows carcinoma of the breast, is most frequent in women. The age of the patients is usually from forty to fifty years.[1]

Symptomatology.—The pains in carcinoma of bone are acute, and appear early. Far from lessening with time, they only increase in severity as the tumor enlarges. The morbid mass sometimes attains a considerable size. Its consistence is usually unequal, certain parts being remarkably soft, and even exhibiting a false fluctuation, which may lead to the belief that there is an abscess, especially if the skin is hot and red. Parchment-like crepitation is rare. On the other hand, it is quite common to find pulsation, expansile movement, and a murmur (Bardeleben), which may lead to carcinoma being mistaken for an aneurismal tumor of the bone. The integuments which cover the growth are distended and thinned. They are very vascular, and are soon destroyed, the neoplasm ulcerating, and giving rise to more or less serious hemorrhages. Spontaneous fractures may complicate both primary and secondary carcinomata of the bones. In a case of carcinoma of the neck of the femur, mentioned by Volkmann, the physician who treated it had believed that it was a coxalgia. A fracture occurred, and this was taken for a spontaneous luxation. The autopsy corrected the mistake that had been made. In carcinoma of the bones, the lymphatic glands are invaded or engorged oftener than in sarcoma. Generalization is constant. Death is the inevitable termination of the affection if left to itself, the mean duration of the disease being then about a year and a half. Holmes found that in twelve cases out of twenty-eight, death occurred in the course of the first year; in five of these cases the affection had not even lasted six months. Secondary carcinoma is ushered in by more obscure phenomena; the pains, tumefaction, and deformities, however, should attract the attention of the surgeon. Spontaneous fractures sometimes have a certain tendency to repair, but almost always the fragments end by remaining ununited. (Malgaigne, Nélaton, R. Volkmann.) Nevertheless, more or less temporary consolidations have been reported. (Follin.)

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[1] Verneuil et Marchand, Dict. Encyclopédique des Sciences Médicales, art. Os.

Diagnosis.—In general, carcinoma, rather than sarcoma, attacks patients of a certain age. Its course is more rapid, the pains are acute and persistent, invasion of the soft parts and ulceration of the skin take place early, engorgement of the lymphatic glands is more common. Finally, generalization is almost constant, and may occur very early. Diffuse carcinomatous infiltration sometimes strongly resembles osteomalacia; but the latter affection usually attacks a greater number of bones, and affects the general condition less rapidly. As for the diagnosis of secondary carcinoma of the bones, it rests entirely upon the detection of the primary tumor which has given rise to it.

Prognosis.—The prognosis is always grave, on account of the frequent recurrences, and of the tendency to generalization. (Jamain and Terrier.)

Treatment.—Whenever it is possible, the whole bone affected with carcinoma should be removed; that is to say, disarticulation is to be preferred to amputation in the continuity. (Follin, R. Volkmann.) This measure is applicable only to the limbs; everywhere else, simple extirpation is an unsatisfactory operation. (Follin, Jamain and Terrier.) Croft[1] amputated the leg of a patient affected with an encephaloid cancer of the lower extremity of the tibia. Ten months afterwards there was recurrence at the lower end of the femur, the surgeon practised disarticulation at the hip-joint, and the patient again recovered from this operation. Unfortunately we do not know what became of him afterwards.[2] In all cases of carcinoma occupying the bones of the limbs, amputation is inevitable; and amputation at the nearest joint should be practised whenever it is possible.

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[1] Lancet, Aug. 24, 1872.

[2] Dict. Encycl.

ORTHOPÆDIC SURGERY: THE TREATMENT OF DEFORMITIES.

BY

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History of Orthopædic Surgery.

Orthopædic Surgery forms an important section of surgical science: it deals with distortions and contractions of the head, trunk, and extremities, affections which differ widely in their nature, and vary much in their method of development; its study includes a consideration of lesions of the muscular and nervous systems, and of diseases and injuries of the bones, joints, fasciæ, and skin; nor is this the limit of orthopædic practice, for a disordered condition of one or all of the processes of respiration, circulation, and digestion, may in some cases be present as a complication, whilst mental disturbance may give rise to, or be itself caused by, a condition of deformity. The classification of such different affections under one heading is apparently unscientific, but the cause of this grouping is made evident when the history of orthopædic surgery is traced.

The treatment of deformities has been practised since the earliest days of surgery, but their effective relief has only been achieved within a comparatively recent period; until the end of the last century the only method of practice pursued was the employment of mechanical appliances, which was attended by a very small measure of success. The first advance in the direction of a more scientific mode of procedure was made by Thilenius, in 1784, who advised, and under whose direction was performed, section of the tendo Achillis in a case of talipes varus; the operation, which consisted in the free division of the tendon by an open wound, was followed by a good result. In 1804, Sartorius divided the same tendon in a boy aged thirteen, who was suffering from talipes equinus consequent upon the formation of an abscess in the calf of the leg; the operation was commenced by making an external wound four inches long, and after some dissection of the parts the tendon was divided; further dissection was considered necessary on account of adhesions existing between the tendon and adjacent tissues, and, finally, forcible manipulations of the ankle-joint were practised. This operation, it is not surprising to read, was followed by great pain and constitutional disturbance, but the boy recovered with his foot in an improved position, though with an anchylosed ankle-joint. Delpech, too, in 1816, treated a case of talipes equinus by section of the tendo Achillis, dividing this tendon by making two lateral incisions about one inch in length, and leaving the superficial tissues at the back of the tendon intact; this operation was followed by suppuration and sloughing of the tendon, which, although a fairly good result was ultimately obtained, probably deterred Delpech from again adopting such a method of procedure. This surgeon appears to have so far profited from his experience that he saw the necessity of modifying his plan of operating, and he gave, in a work published in 1828, this advice: "the tendon to be divided should not be exposed; its section should be made by a *détour*, and not by an incision parallel to that of the skin;" but the rule thus prescribed was never practically carried out by Delpech, so that although he first theoretically counselled subcutaneous tenotomy, it remained for Stromeyer to perform and introduce the operation. The great advance in the method of dividing tendons which Stromeyer devised, consisted in making the external wound a mere puncture; Delpech, in the rule above quoted, speaks of the wound made in the superficial tissues as an *incision*, so that although Stromeyer was no doubt to some extent assisted to the discovery he made by his predecessor's theoretical advice, yet his evolution of subcutaneous tenotomy must have been chiefly the result of original thought. Dr. Little gives the following translation of Stromeyer's description of the operation of dividing the tendo Achillis:[1]—

> The operation must invariably be effected by puncture without external incision. A small, moderately curved, sharp-pointed bistoury is adapted for most occasions. The limb should be extended in order to produce the necessary projection of the tendon, when the instrument should be passed behind it, the point perforating the opposite skin; division of the tense resisting tendon being effected rather by pressure of the edge than by its slow and cautious onward movement. The skin, being elastic, yields to the pressure of the knife, the two punctures not exceeding its width. I have frequently divided the tendo Achillis in this manner without producing a second puncture; but this is of little moment, as two minute punctures heal as quickly as a single one. The division of the tendon is known by an accompanying sound, which can scarcely be mistaken. The performance of the operation with the point of the instrument is less to be relied on, partly from its being too weak, and also because the operator can be less certain of not causing injury to other structures in the event of the patient not remaining quiet throughout the operation. . . . . The attempt to commence extension directly after the operation, and the endeavor immediately to restore the limb to its natural position, which will very seldom succeed, and, as the case of Sartorius proves, can only be effected by great force, is neither necessary nor advisable. The commencement of extension before cicatrization of the wound in the integuments is unadvisable even when possible, as it may produce inflammation and suppuration not confined to the vicinity of the wound; it is unnecessary, inasmuch as the tension of the divided muscle is not restored during the gradual mechanical extension applied subsequently to the healing of the wound, but occurs after the complete reunion of the tendon, and after the necessary motions of the limb during exercise have acted as a stimulus to its contractility

Stromeyer's operation, although at first received with some opposition, was soon established as a safe and reliable mode of treating club-foot. Dieffenbach, of Berlin, adopted subcutaneous tenotomy with much enthusiasm, and the practice was also followed by Duval, Bouvier, and Guérin, of Paris, Scoutetten, of Strasbourg, and other continental surgeons. In England, section of the tendo Achillis was performed by the late Mr. Whipple, of Plymouth, in the year 1836, but he appears not to have repeated the operation, and the case resulted in nothing further than enabling this gentleman to lay claim to a priority of performance of the operation amongst his countrymen. With Dr. Little rests the honor of introducing subcutaneous tenotomy to his professional brethren in England; Dr. Little himself, having the misfortune to suffer from deformity of the foot, at once appreciated the value of Stromeyer's method of treatment, and hastened to place himself under the eminent German's care. Greatly benefited by the treatment, Dr. Little remained to study Stromeyer's practice; on returning to England, in 1837, he laid before the profession the valuable results of his experience, and chiefly by his efforts was a special hospital for the practice of orthopædic surgery established in London.

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[1] Treatise on the Nature of Club-Foot. London, 1839.

The introduction of subcutaneous tenotomy by Stromeyer was followed by results which can scarcely be estimated at too high a value. No sooner was it found that the treatment of club-foot had at last been undertaken upon scientific principles, than surgeons began to direct their attention to other forms of contraction and distortion, and the operation of subcutaneous tenotomy was applied with success in cases which had before been considered incurable, and the treatment of which had been relegated to the quack and empirical machinist. Like all other discoveries, subcutaneous tenotomy was at first employed somewhat recklessly, but this want of appreciation of its capabilities was soon corrected, and laws for its fitting performance were established by the investigations and labor of many able men. The mechanical appliances previously in use were discarded or improved, and the machinist's ignorance of the anatomy of the deformity which he endeavored to remedy by his ill-contrived appliances, was reformed by the science of the surgeon. From subcutaneous tenotomy sprang that still greater field of practice, general subcutaneous surgery, which, although not limited to the treatment of cases of deformity, was, together with a corrected knowledge and improved use of mechanical apparatus, the foundation of the special branch of practice called orthopædic surgery. Orthopædic surgery then, if it is to be considered a separate section of our science, is a specialty of treatment; it confines its therapeutic benefits to no one organ of special sense or function, nor indeed to one special class of cases; for although it deals with the treatment of deformities, all deformities are not brought within its range —such for instance, as hare-lip, cleft-palate, and spina bifida—because the treatment of these affections does not belong to subcutaneous surgery.

The treatment of the various conditions of contraction and deformity which we have now to consider, is a subject full of interest to all surgeons; few greater benefits can be conferred upon suffering humanity than that given by the removal of distortion—an affliction which, whatever may be its particular nature, is most distressing to its unhappy subject, both physically and mentally. One attribute belongs peculiarly to this branch of practice and lends to it especial interest: the practitioner is almost entirely compelled to rely upon his own care and resources in obtaining a satisfactory result; he has not simply to place the affected part in a favorable condition for nature to effect the cure, but, on the contrary, he has by constant attention to combat opposing forces until a complete restoration to the normal state, if such be possible, has been gained—a termination to the case which can only be arrived at by careful attention to details and established rules of practice. Orthopædic surgery cannot yet be described as a perfect art, but this much may be allowed: that, as far as our knowledge goes, it is an exact science, and that the surgeon who has studied its practice with a reasonable amount of care, may confidently assure himself that he knows to what extent he can relieve any particular condition of deformity which he may have to encounter.

The conditions of deformity, the treatment of which pertains to orthopædic surgery, as has already been noticed, differ widely in their nature, and it may be further remarked that they vary much in the relative frequency of their development; three thousand consecutive cases which have passed under the writer's personal observation were constituted as follows:—

Deformities of spine	937
Club-foot	581
Curvature of the bones of the leg	743
Genu valgum	526
Other deformities of lower extremity	158
Deformities of upper extremity	42
Wry-neck	13
	3000

Club-Foot.

The term club-foot was at first applied to only one form of distortion of the foot, but it now includes several affections which present marked differences of character; for these affections Dr. Little suggested that the generic term *talipes* should be employed, and this nomenclature is now universally adopted, the deformities being classified in four groups under the names of talipes equinus, talipes calcaneus, talipes varus, and talipes valgus. The characteristic features of each of these varieties of deformity are well defined, and clearly distinguish the different groups; thus, the subject of distortion being in the erect position in *talipes equinus*, the forepart only of the foot touches the ground, the heel being raised and not used in progression; in *talipes calcaneus* the front of the foot is raised and the heel only affords support; in *talipes varus* the outer border of the foot is on the ground, and the inner border is turned upwards and inwards; in *talipes valgus* the outer border is raised, and the inner side of the foot is depressed. A verbal description of these four conditions of talipes indicates that the first two, equinus and calcaneus, present opposite points of deformity, and that the last two, varus and valgus, differ in the same manner; this is to some extent true, but beyond the fact that the shape of the foot assumed in the respective conditions of equinus and varus, is so far different from that obtaining in calcaneus and valgus, that in the former cases the part of the foot which touches the ground is in the latter the part which is raised, and *vice versa*, the various deformities possess no other points for comparison, and each must be considered as a separate subject and be studied independently. A further elaboration of the grouping of the various forms of talipes has also been adopted by classifying certain combinations of these deformities which not unfrequently occur; thus there are described talipes equino-varus and equino-valgus, calcaneo-varus and calcaneo-valgus—distinguishing titles which are justified by clinical facts; it will, however, be more convenient for description to keep to the simple forms, and consider the different combinations according as the chief characteristic of distortion represents equinus, varus, calcaneus, or valgus.

The development of club-foot depends upon numerous *causes* which differ considerably in their mode of action; certain of these productive influences may be exercised on the fœtus, giving rise to one or other of the forms of talipes, and the etiology of congenital deformity will have to be considered when talipes varus, which is by far the most common variety of congenital club-foot, is described. The non-congenital or acquired forms of talipes almost invariably originate in disturbance of the nervous system, and in consequent excitation of muscular abnormality. When this muscular abnormality coexists with non-congenital club-foot, it presents itself under two conditions which differ widely from one another. In one state the muscles are tense, firm, and well developed, but they do not properly respond to nervous influence, and their action is therefore ill-regulated. In this condition of the muscles, which is called "spastic contraction," the fibres have become permanently shortened and have lost the power of normal extension—a result which is generally due to their having been thrown into violent action through reflex irritation of the motor nerve-system in early life. The various affections which give rise to convulsions in early childhood, may, any one of them, leave this state of permanent muscular contraction; thus, the eruption of the teeth, intestinal irritation, due either to the presence of entozoa or to the administration of improper food, and exposure to cold, are all exciting causes of spastic contraction, while the same condition is also frequently developed in infants born before the full period of gestation is completed, and in those whose period of birth has been normal, but in whom, from prolonged labor or other causes, the performance of the processes of respiration and circulation has been delayed. The contraction of the muscles excited in such cases is most probably dependent upon reflex irritation of the motor nerves through the sensory or sympathetic systems, and not upon lesion of the nerve-centres; that the stimulus is reflex, is beyond doubt in the conditions first named, such as teething, etc., in which local irritation is present, whilst in the case of infants prematurely born, the irritation of the nerves is to be accounted for by the demand made upon tissues not yet perfected, to fulfil the functions which are necessary for a separate existence.

When spastic contraction affects the muscles of the leg and foot, deformity is very sure to occur, the progressive formation of which will have to be considered when describing the different varieties of club-foot. It must be remarked that deformity of the foot is not the only distortion that arises from this tonic muscular spasm, the result of nerve irritation; any part of the body liable to the same influence may become distorted, but for convenience of description this fact may be disregarded for the present, and attention may be directed merely to the condition of foot-distortion. Accompanying the local muscular disturbance there is not unfrequently present a defective condition of the intellect; children who are subjects of this affection are nearly always slow in learning to talk, although they may readily understand what is said to them; they are dull and stupid, and in the more severe cases they may be semi-idiotic.

The other state of muscular degeneration which has been referred to as one of the chief causes of non-congenital deformity of the foot, is of quite a different character from that just described. The muscles are to a greater or less degree wasted, and their tissue is softened; their contractile power is diminished or altogether lost, and they consequently either act feebly, or fail entirely to respond to the nervous stimulus. This affection of the muscles results from a lesion of the nerve-centres, that somewhat obscure affection which attacks children at about the age of from one to three years, and which is commonly known as *infantile paralysis.* The clinical history of this disease is well known: that it is often insidious in its onset, being ushered in by no premonitory symptoms; or again that slight feverishness may precede the attack; or that it may be the sequel of scarlet fever, measles, whooping-cough, or other exhausting disease. Paralysis more or less complete of the muscles of the extremities, the onset of which is remarkable for the suddenness of its appearance, is the chief characteristic of this disease. The attack is usually limited to one side of the body—the leg, and it may be also the arm on the same side, being affected; the muscles of both legs may however be paralyzed, or the leg on one side and the upper extremity on the other may be simultaneously attacked. The paralysis varies greatly in degree, from a slight loss of muscular power, which passes by unnoticed, to complete loss of muscular power; sensation is not impaired, the lesion being limited to the motor nervous system. There is much difference in reference to the liability of the separate muscles to become influenced by the disease; all the muscles of the leg may be affected, or the paralysis may affect only single muscles or groups of muscles; and even when the attack is general in its effects, the degree of paralysis is nearly always greater in some muscles than in others, those which especially suffer being the extensors of the toes (flexors of the foot) and the tibialis anticus. The seat of mischief in this disease is central, and consists, as far as we are acquainted with the nature of the malady, in a lesion of the motor centres of the spinal cord; but we are not in possession of evidence to account for the fact that the motor centres are affected in such a manner as to induce paralysis of certain muscles much more frequently than of others.

These two conditions of nerve-lesion and muscular disorganization are the chief causes of non-congenital club-foot; I have made no endeavor to describe the nature of these diseases, as a full discussion of them would be impossible without encroaching on space required for matter with which this article is more directly concerned; all that has been attempted is to draw attention to these sources of deformity, and further elucidation of the subject must be sought for in the works of authorities on disorders of the nervous system.

The order most convenient to follow in describing the varieties of club-foot, will be to take talipes equinus first, and then talipes varus, since the latter deformity is frequently combined with the former; next talipes valgus will follow, and finally talipes calcaneus. The development of one or other of these deformities is of sufficiently common occurrence to make them all of importance to the surgeon; of the 581 cases of distortion of the foot already referred to, 151 were examples of equinus, 206 of varus, 175 of valgus (including flat-foot), and 49 of calcaneus; as a congenital deformity varus is by far the most common, but as a non-congenital deformity equinus is most frequently met with.

Before describing the various forms of club-foot in detail, a few general remarks may be made upon the operation of *tenotomy.* Section of a tendon should only be employed when contraction of the affected muscle is confirmed, but when this state has become established, tenotomy is the only means by which it can be relieved. The knife should be entered at a little distance from the side of the tendon, and on a level with its superficial surface; it should then be pushed downwards, with its flat side directed towards and touching the tendon, until the deep surface of the latter is reached and the blade is well beyond it; the cutting edge is then turned, and the section of the tendon is made towards the skin. As small a knife as possible should be selected, but the steel must be strong and well-tempered; the shape of the blade is of no particular importance, and the surgeon may consult his own convenience in this respect. When the knife is withdrawn, the puncture is sealed with a pad of lint and a piece of strapping; repair is then carried on without the occurrence of unhealthy inflammation. The process of repair consists in the exudation of lymph between the cut ends of the divided tendon; the investigations of Adams[1] have clearly shown that it is from this new material alone that the new tendon is formed, and that any blood that may be present is absorbed and does not become organized; the lymph is chiefly supplied by the connective tissue which forms the sheath of the tendon. The presence of nuclei and nucleated cells is the first step in the organization of the new material; capillary bloodvessels are next formed, and elongation of the nuclei takes place; the lymph soon presents a fibrillated appearance, and in the course of time becomes distinctly fibrous in structure. The new portion becomes fused with the old tendon in such a manner that it is scarcely possible to distinguish between them, the only difference being that the former is somewhat translucent, and of a slightly grayish color.

Talipes Equinus.—Talipes equinus is so called because the deformed foot presents some resemblance in shape to the foot of a horse; the simplest form of distortion occurs as a congenital affection, when from contraction of the extensor muscle of the foot the heel is raised and the toes are pointed downwards. Congenital equinus is very seldom met with; but Little and Adams have both recorded cases, so that all doubts, and such have been expressed, as to the occurrence of this deformity at birth, are set at rest. The cases quoted by Dr. Little are of especial value, since in two instances the subjects were the sons of a surgeon; the eldest child of the family was affected with the deformity, and was treated with success by Dr. Little, and the youngest and eleventh child was also born with equinus, which, although not of a severe grade, was sufficiently marked to necessitate the employment of mechanical treatment for its relief. A case of congenital equinus has never come under my own notice, but on page 1019 (Fig. 1473) will be found an illustration of equino-varus existing at birth, and in which the complication of varus was very slight indeed—only sufficient to warrant the classification of the case as one of equino-varus and not of simple equinus.

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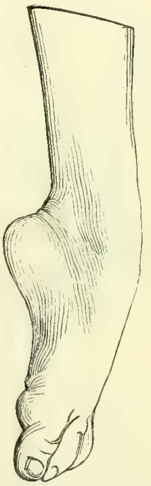
[1] On the Reparative Process in Human Tendons. London, 1860.

Paralytic Equinus.—The most common form of non-congenital talipes equinus results from paralysis of the extensor muscles of the toes, the peculiar liability of which muscles to become affected in infantile paralysis has already been alluded to. The condition of the foot in this particular form of the affection will be found to vary according to the nature of the muscular defect; Fig. 1465 illustrates the external appearances presented in one variety of the distortion. In this case the foot was extended to an extreme degree upon the leg, the heel was raised, and the dorsum was directed forwards and slightly downwards; such a condition results from complete paralysis of the flexor muscles of the foot, the power of flexion being thus lost, and the foot falling into the position of full extension. When the cast of the foot, from which this drawing is copied, was taken, the paralysis had existed for about four years, during which time no recovery of the affected muscles had taken place; and from the unbalanced action of the gastrocnemius and soleus muscles the heel had become raised, and the foot extended much beyond the normal degree. It will be noticed that the toes were directed somewhat backwards, and that the arch of the foot was unnaturally deep; in walking, the foot became folded up so that the front of the toes and part of the dorsum of the foot were placed on the ground, and, had the deformity remained unrelieved, the foot would gradually have become retroverted on the leg, the sole being directed upwards and backwards, and the dorsum of the foot turned directly downwards. The condition of equinus here represented is the least common variety of the paralytic affection; as a rule, the flexor muscles partially regain their power of contractility, or they are not completely paralyzed when first attacked, in which cases the foot presents different characters of distortion. The partial restoration of the extensor longus digitorum and proprius pollicis muscles, causes the toes to be drawn up towards the dorsum of the foot as shown in Fig. 1466; the parts of the foot which then reach the ground are the ends of the metatarsal bones and the extremities of the toes, and on the surface of the skin corresponding to the ends of the metatarsal bones, the cuticle becomes hardened and thickened to much the same condition as that of the normal heel. The weight of the body is carried directly through the foot, and from the pressure thus thrown upon it the arch becomes greatly deepened, and the sole of the foot is much shortened. This shortening of the foot is entirely a mechanical process, and is not due to active contraction of the muscles and fasciæ of the sole, although these tissues acquire a condition of confirmed contraction from their points of attachment being brought abnormally near to one another. The establishment of this feature of the deformity is clearly shown in Fig. 1466, where

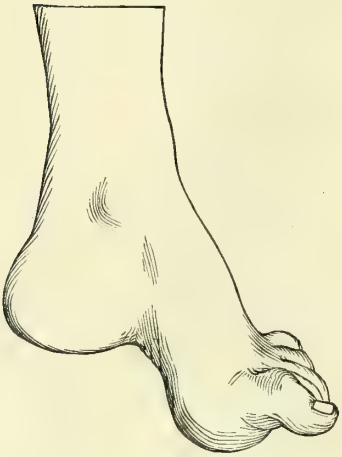
Fig. 1465.



Paralytic equinus; complete paralysis.

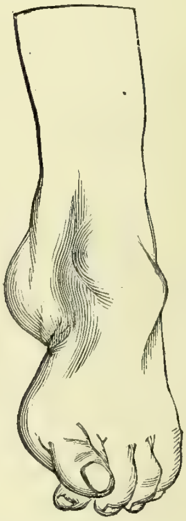
another important character of the distortion is also illustrated; from the partial recovery of the anterior muscles, the extensors of the foot are to some degree antagonized, so that the heel is not drawn up to the same extent that it is in the condition of persistent paralysis illustrated in Fig. 1465. If the forepart of the foot, in front of the astragalus and os calcis, is hidden from view, the heel will be found to be in its normal position; therefore, if the distortion of the foot itself, the shortening of the sole, and the contraction of the toes, were removed, the patient would be able to stand well on the plantar surface of the foot. If allowed to continue unrelieved, this condition of deformity passes on to a state of great severity; the continued pressure on the arch of the foot still further increases the shortening of the sole, as is shown in Fig. 1467, and the forepart of the foot, which touches the ground, spreads out and becomes abnormally wide. In this case there is on the dorsum of the foot a marked prominence at the seat of the calcaneo-cuboid and astragalo-scaphoid articulations (the transverse tarsal joint), arising from the bones in the front of the foot becoming depressed, and from the head of the astragalus being exposed and projecting forwards on the dorsum.

Fig. 1466.



Paralytic equinus; partial recovery of anterior muscles.

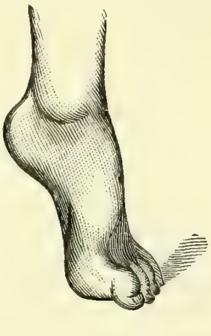
Fig. 1467.



Paralytic equinus; severe stage of same deformity as shown in Fig. 1466.

Spasmodic Equinus.—Talipes equinus, the result of spasmodic contraction, differs in some important respects from the paralytic variety of the deformity, the chief feature being that the distortion of the foot itself is not as severe. The extensor muscles of the foot are especially liable to become affected with spastic contraction, from irritation of the nerve-centres during infancy, and a gradual shortening of the gastrocnemius and soleus muscles, with contraction of the tendo Achillis, occurs. This contraction is increased when the subject uses the muscles in walking, and thus it often happens that a child in whom the shortening is not sufficient to prevent the foot from being fairly flexed on the leg, when examined with the muscles at rest, is yet unable to place the heels on the ground when walking; from this state the contraction may gradually increase until the foot can only be brought to a right angle with the leg, and still further, until a confirmed condition of extension of the foot to a greater or less degree is established. The character of this deformity is well shown in Fig. 1468, which exhibits an extreme degree of spasmodic equinus; the foot is fully extended upon the leg and the heel is raised, the toes are drawn up, and the arch of the foot is somewhat increased in depth; this case is illustrated in Mr. Adams's work on club-foot,[1] from which the drawing here given is copied. This case should be compared with that of paralytic equinus, Fig. 1466; in both the same part of the foot is placed on the ground, and the toes are drawn up to much the same extent, yet the differences in the distortion of the two feet are very marked. In the spasmodic variety the heel is raised, in the paralytic it is in its normal position; in the former the foot is but slightly shortened, in the latter the sole is much contracted; in both the phalangeal extremities of the metatarsal bones are somewhat widened, and the forepart of the foot is abnormally broad. This variation in the nature of the two conditions of equinus, is due to the limb affected with paralysis being wanting in vitality in all its constituent parts: the bones are small, both in length and circumference; the fibrous tissue of the ligaments is defective in tenacity; the skin is livid, and in cold weather purple in tint—all these defects being due to malnutrition and insufficient blood-supply. In spasmodic equinus no such general wasting occurs; there is increased contractility of the affected muscles, and there the mischief ceases; the structures of the foot are therefore better able to bear the weight of the body than are the weakened tissues of the paralyzed limb.

Fig. 1468.



Spasmodic equinus. (After Adams.)

Other Forms of Equinus.—Talipes equinus occasionally results from other causes than those already described. A very similar condition to that of spasmodic equinus arises from local irritation of the extensor muscles of the foot; a wound or other injury of the calf, the formation of abscess in the same situation, reflex irritation of the muscles from rheumatic or other inflammation of the ankle-joint, may all be exciting causes of the deformity. Equinus may also arise from a wound of the anterior tibial nerve giving rise to paralysis of the flexor muscles of the foot; it may also be purely mechanical in its origin, as when the foot is kept for a long period in the extended position and permanent shortening of the extensor muscles becomes established; again, extensive ulceration of the skin, or a severe burn, on the back of the leg, may induce the deformity. Such conditions must be regarded as spurious forms of the distortion; but a knowledge of the pathology and treatment of the typical conditions of equinus will greatly assist the surgeon in the management of such cases.

Treatment of Talipes Equinus.—In entering upon the treatment of a case of talipes equinus, the surgeon has first to satisfy himself as to the original cause of distortion, and next to determine how far the deformity consists of changes in the shape of the foot itself, and what alteration has occurred in the normal relationship of the foot to the leg. The three characteristics of equinus have been noted as widening of the forepart of the foot, shortening of the sole with contraction of the plantar fascia, and elevation of the heel; of these three conditions, the former never exists without the two latter being present, and only occurs in cases of severe deformity of some years' standing, while the two latter may exist together or separately. The relative degree to which the three conditions are present in any case, depends upon the original cause of the deformity, and upon the length of time that it has existed. In equinus the result of paralysis, the characteristics of the deformity will be determined by the nature of the disturbing influence in the initiatory nerve-lesion; when paralysis of the anterior muscles is complete and persistent, the foot falls to a state of extreme extension, which is increased by contraction of the gastrocnemius and soleus muscles; accompanying such a condition there may also be general loss of power of the muscles of the lower extremity, to such an extent that the subject has no power to use the leg in walking or standing; a crutch is used, and the foot is never subjected to pressure from having to bear the weight of the body, and the deformity does not advance beyond the stage of abnormal extension of the foot upon the leg. When the limb is used, the progress of the deformity in these cases of extreme paralysis consists in folding backwards of the forepart of the foot in the manner already described; distortion of the foot is then added to the extension at the ankle-joint. When after the paralytic attack the flexors of the foot retain some power of contractility, the condition of equinus-development will be of the nature illustrated in Figs. 1466 and 1467; in such cases the principal feature of deformity is the change in the shape of the foot itself. In spasmodic equinus, where contraction excited in the extensor muscles is the immediate cause of distortion, and where the foot is from its inherent strength able to support fairly well the pressure to which it has to submit, the extension of the foot on the leg is the most prominent symptom, and only in long-standing cases do shortening of the sole and widening of the metatarsal bones take place. The following tabular statement of the various stages of paralytic and spasmodic equinus, will perhaps render clearer the points to be observed in deciding upon the course of treatment to be adopted for relief of the deformity.

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[1] Club-Foot, its Causes, Pathology, and Treatment; 2d edition. London, 1873.

PARALYTIC EQUINUS.	*Early stage.*	*Advanced stage.*
Slight loss of power of flexor muscles.	Partial falling of foot, with slight contraction of tendo Achillis.	Slight contraction of plantar fascia and deepening of arch of foot. Tendo Achillis very slightly if at all contracted.
Greater loss of power of flexor muscles.	Considerable falling of foot, drawing up of toes, and inability to flex foot beyond a right angle.	Considerable deepening of arch, and contraction of plantar muscles and fascia; widening of forepart of foot; heel slightly raised.
Complete loss of power of flexors of foot.	Extreme extension of foot on leg, with elevation of heel.	Forepart of foot folded backwards, and dorsum placed on the ground; heel raised. If general paralysis of lower extremity exists, the foot remains as in first stage.

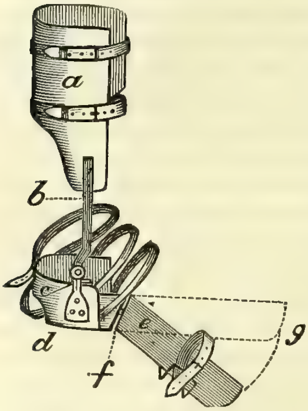
SPASMODIC EQUINUS.	*Early stage.*	*Advanced stage.*
Slight contraction of extensors of foot.	Achilles tendon slightly contracted; heel raised an inch or so in walking, but foot can be flexed when muscles are at rest.	Foot can only be brought to right angle with leg; heel much raised when walking. Slight contraction of sole of foot.
Severe contraction of extensors of foot.	Increased contraction of tendo Achillis. Foot can only be flexed to a right angle when leg is at rest.	Heel much raised, and walking powers very defective; contraction of tendo Achillis very marked; arch somewhat deepened, and forepart of foot widened.

To relieve the deformity of the foot, the measures of treatment that may be resorted to are of three kinds: mechanical treatment, which consists in the use of various instruments intended to bring the foot to its normal shape;

operative treatment, which involves the subcutaneous division of contracted tissues; and physiological treatment, as it is called, which is the employment of manipulative exercises, shampooing, galvanism, and other allied processes. In the several conditions of equinus, these methods of treatment, one or all, are employed according to the nature of the existing distortion. Taking first a case of paralytic equinus, with partial recovery of the anterior muscles, and the foot in the condition represented in Fig. 1466, the treatment to be adopted for the relief of the deformity, which is one of the type most commonly met with, must be directed to remedy the distortion of the foot itself, and to overcome any obstacle that may exist to the free movement of the foot upon the leg. The distortion of the foot consists chiefly in a displacement of the scaphoid and cuboid bones from the astragalus and os calcis, the anterior part of the foot being in fact partially dislocated from the posterior at the transverse tarsal joint; this displacement is maintained by acquired contraction of the plantar fascia, and possibly also by shortening of the superficial muscles of the sole of the foot. Movement at the ankle-joint is restricted by some contraction of the Achilles tendon, and also by want of use; in such cases the foot cannot be flexed beyond the right angle, or this movement may be still more limited. The chief characteristic of deformity is the distortion of the foot proper, and to reduce this must be the first object of treatment, the relief of the impeded movement of the ankle-joint being attempted afterward. This course of action is pursued because the fixing of the os calcis, and with it the astragalus, is of great help to the surgeon in using measures for reducing the distortion of the foot; for, just as in the case of a dislocated limb, he thus obtains an immovable base on which to return the displaced parts; if, on the contrary, the mobility of the ankle-joint be first restored, the want of stability of the posterior bones will render the reduction of the distorted foot a very difficult task, if not an impossibility.

The first step in treatment is to overcome by *subcutaneous section* the contraction of the tissues in the sole of the foot, and care must be exercised to ascertain what is the amount of structural shortening present; it is not always possible to decide this point with exactness, for the tightened superficial tissues may hide the contraction of deeper structures. The sole of the foot must be put on the stretch by fixing the heel and forcing forwards the forepart of the foot, when the greatest resistance to extension will usually be found to be at the inner border of the plantar fascia; in order to discover the full degree of contraction, the nail of the fore-finger should be pressed against the inner edge of the tightened band, as though trying to hook around it, and should be pushed up into the sole to discover if possible the depth to which the contraction extends. In performing the operation, the patient is so placed that the plantar surface is directed upwards, and an assistant holds the foot and stretches the contracted tissues by making a moderate degree of extension; a sharp-pointed tenotome, with a good stiff blade about an inch or an inch and a quarter in length, according to the extent of contraction present, is selected, and is passed through the skin about an eighth of an inch from, and with the flat side directed towards, the inner edge of the band; the blade is pushed onwards and made to sweep around the whole of the contracted tissues, when the edge is turned, and, the assistant extending the foot as much as possible, the resisting structures are divided with a few even strokes of the blade. The knife is next withdrawn, and the puncture closed with the finger whilst the foot is examined, to discover if any portion of contracted muscle or fascia still remains undivided; such will be the case if the knife has not been carried deeply enough, or sufficiently to the outer side, when making the first incision; then the tenotome must be entered again at the puncture and the necessary division completed. In cases of long standing, the abductor pollicis muscle and the adjacent fascia generally spring out in prominent relief after section of the central contraction has been made; when they do so, they must be divided either through the first opening, or, which is perhaps better, by making a fresh incision about an inch and a half behind the great toe. Complete section of the contracted muscle and fascia having been obtained, each small wound is closed with a pad of lint fastened by a piece of strapping, and over this a larger pad is placed to produce pressure and prevent subcutaneous hemorrhage from any small vessels that may have been divided, the whole being secured by a bandage; a flexible splint, well padded, is then placed on the leg and foot to keep the latter at rest. After three days all the dressings are removed, and the superficial wounds, which are merely small punctures the size of the blade of the knife, will be found to be completely healed; mechanical treatment is then at once commenced.

Fig. 1469.



Adams's shoe for treatment of talipes equinus.

The object of *mechanical treatment* is to keep the foot in the improved condition in which it can be placed after the division of those structures in the sole which by their contraction contributed to the deformity, and to overcome other obstacles which still exist to complete restoration of the foot to its normal shape, and which are not amenable to operative interference. In a case of advanced deformity of the nature illustrated in Fig. 1466; the forepart of the foot cannot be put in its proper place after section of the plantar fascia, because the ligaments connecting the under surfaces of the astragalus and os calcis with the scaphoid and cuboid bones have become structurally shortened, a condition which can only be overcome by long-continued mechanical extension. The instrument employed for this purpose is a Scarpa's shoe, which is admirably devised to fulfil the requirements of practice; this shoe, as improved by Mr. Adams,[1] consists of a sole-plate divided at *t*, and supplied with a cog-wheel allowing the forepart of the plate *e* to be raised and lowered in the direction of the dotted line *g*; to the heel-piece are attached three straps, of which the central one passes over the front of the ankle-joint, and then between the side of the heel and the heel-piece, through the slot cut at the back of the latter, to be fastened to a buckle on the outer surface; this strap, which is called the skate-strap, is of great assistance in fixing the heel firmly in the shoe. On the forepart of the sole-plate there is a strap and toe-wire by which the front of the foot is fastened to the instrument; connected with the heel-piece is the steel bar *b*, bearing the calf-plate *a*, and a cog-wheel, placed at *c*, permits of flexion and extension being made at a point corresponding to the ankle-joint. The foot and leg having been evenly covered with a bandage, the instrument before it is applied is first "set" so as to exactly correspond to the original condition of deformity; the heel-piece is raised to the degree of elevation of the heel present in the affected limb by using the cog-wheel corresponding to the ankle-joint at *e*; and the front of the sole-plate is lowered by the cog-wheel at the division *f*, to an extent equal to the distortion of the foot at the transverse tarsal joint. In applying the instrument, the surgeon, sitting below and in front of his patient, and flexing the knee to about half a right angle, drops the affected limb into the instrument; the skate-strap is then fastened with the other straps at the heel; next the calf-plate is fixed; and finally the front of the foot is secured to the sole-plate.

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[1] Op. cit., page 136.

The whole success of the mechanical treatment of the case depends upon the skill with which the instrument is applied and used, and from a want of appreciation of this fact an imperfect result very frequently follows; it is quite remarkable how one can blunder in his first attempt to apply a Scarpa's shoe, the trouble usually arising from not properly adjusting the shoe according to the condition of deformity, and from fastening first the wrong parts of the instrument. If the former of these errors is committed, the heel of the foot does not properly fall into the heel-piece of the shoe; having overcome this fault, the course above described of commencing by fastening the heel, then the calf-plate, and finally fixing the forepart of the foot, should always be followed; by so doing the part of the appliance which is kept immovable during this stage of treatment is first made firm, and then the acting portion of the appliance is put ready for use. For the first twenty-four hours, the limb is merely kept resting in its original state of deformity; the instrument is then taken off, and the foot and leg are examined to see if too much pressure has been exercised at any one spot from over-tightening of the straps; a fresh bandage is applied, and the instrument replaced, the front of the foot being raised upwards as much as can be comfortably borne by the patient. The elevation of the displaced structures is daily carried on by the mechanical extension thus exercised; no attempt must be made to force the foot into shape by bringing into play the full power of the instrument; if such a strain is put upon the foot as to give rise to swelling or pain, the pressure must be immediately relaxed, as otherwise the skin will be excoriated by the tightened straps, and the only remedy will be to give up treatment until the abraded surface is again sound. It may be accepted as a golden rule in the mechanical treatment of this and all other varieties of deformity, that the instrument in use should be applied firmly but should never be tightly fastened. The reduction of the deformity of the foot in a case such as is now being considered, will take from two to three months to complete, and when the contraction of the plantar surface has been overcome, the restoration of free movement at the ankle-joint must be proceeded with.

At this stage of treatment is presented the first difficulty in deciding upon what measures are the best to adopt; as to the necessity for operative treatment in the first stage, no room for doubt exists, but whether or not it is desirable to resort to tenotomy for the restoration of free movement at the ankle, is a more open question. The obstruction here depends upon shortening of the gastrocnemius and soleus muscles, with contraction of the Achilles tendon, and also upon stiffening of the joint from want of use. The first of these causes arises from acquired, as distinct from active contraction; that is to say, the muscles and tendon have become shortened, not from any change in their normal properties, but from being placed in a condition which has prohibited their healthy action. Upon this arises the difficulty of selecting what course of treatment to pursue, whether to relieve the contraction by section of the Achilles tendon, or whether to rely upon a constant application of mechanical extension, combined with physiological measures, to overcome the shortening of the muscles. The limb must be examined to ascertain to what extent the contraction of the Achilles tendon prevents the movement of flexion in the joint; if the case is one of long standing, and the foot cannot be brought to a right angle with the leg when the limb is straight, and the patient is also unable when standing up to flex the leg further on the foot without raising the heel, it is necessary to resort to tenotomy; if, on the other hand, flexion beyond the right angle can be obtained to such an extent that the patient, with the foot placed on the ground, can bend the knee so far forwards as to bring it in a line with the great toe, tenotomy is not required; it is the condition of contraction between these two degrees which renders the question of resorting to section of the tendon one requiring some care to decide upon.

Section of Tendo Achillis.—The division of this tendon in a healthy leg, or when practising on the dead subject, is a very simple operation; but in the case of paralytic equinus, it is by no means so easy to divide the tendon deftly; in the paralyzed limb all the tissues are much wasted, there is consequently very little subcutaneous fat, and the skin folds closely over the tendon, bringing it into strong relief. This is so far an advantage that the size of the tendon can be readily computed, but it renders the performance of subcutaneous division much more difficult than it would be if the superficial tissues were less closely adjacent to the structure which has to be divided. The dangers which have to be avoided are, making a second puncture of the skin on the opposite side of the leg to that on which the tenotome is entered, increasing the size of the first puncture during the section of the tendon so as to produce a gaping wound, and lastly cutting through the skin over the tendon after division of the latter has been completed. All these accidents have frequently happened in practice: the first is of no great importance, but the two latter may lead to serious complications; they usually arise from too great haste on the part of the operator to complete the section of the tendon, although the misfortune of cutting through the skin over the tendon may be chiefly due to want of caution on the part of the assistant who holds the limb. In performing the operation, the patient is placed in the prone position, and an assistant, standing on the left side of the operator, tightens the tendon by holding the leg firmly with his left hand and with his right grasping and flexing the foot; the calf of the leg must not be gripped tightly so as to interfere with the circulation, nor must the foot be too forcibly flexed. The operator enters the tenotome, holding it as he would a pen, at the thinnest portion of the tendon, about a line from its edge, and, in the position in which the patient is placed, near its upper surface,[1] the flat side of the blade being towards the tendon; the knife is pushed obliquely downwards, and passed behind the tendon until the edge of the latter opposite to the side of puncture is reached; the handle is then depressed until the knife is horizontal, when the cutting edge is turned and the tendon divided by even strokes of the blade; as the last few fibres are divided, the knife must be kept under command, since otherwise, especially if the foot is forcibly flexed, the blade will be jerked against the skin and an open wound made over the tendon. The object of entering the knife well above the lower surface of the tendon, and passing it obliquely downwards, is to avoid enlarging the puncture during the performance of the operation; if entered too low down, the handle has to be depressed, and the tendon is scratched through with the point of the knife instead of with a few free sweeps of the blade. The complete division of the tendon is followed by separation of the divided ends, the amount of space which intervenes depending upon the contractile power of the gastrocnemius and soleus muscles. If these are much wasted, the space will be very small; but if they are in a fairly healthy condition, the separation will be to about the extent of one inch.

If the tendon has not been perfectly severed, the knife has probably pierced its deeper fibres instead of passing underneath it, or else it has not been carried far enough to the side opposite to that of puncture, and some fibres at the edge of the tendon have been left undivided; in such cases the knife must be entered again and the section made complete, and the same must be done if the small plantaris tendon has not been severed. The operation should be a bloodless one, a result which is to be obtained by keeping the knife as close as possible to the side and under surface of the tendon. There is some slight risk of wounding the posterior tibial artery if the knife be entered on the tibial side of the leg, and pushed too far down before turning it; but this may be avoided by entering on the fibular side, and this is the safest course to pursue with infants or very young children; in older subjects, either side of the leg may be entered if the knife be kept within proper limits. After the operation, the small wound is closed with a pad of lint and strapping, another pad of lint is placed over this, and the limb is secured to a flexible splint with the foot in the extended position. At the end of four days the dressings may be removed and the use of the Scarpa's shoe be resumed; by using the cog-wheel at *c*, flexion of the foot and lengthening of the tendon must be gradually obtained, treatment being carried on very slowly; for if too much haste is made in these cases of paralytic equinus, the union will be weak and the new tissue will always be liable to stretch and leave the patient with the opposite condition of deformity, calcaneus. It is never desirable to restore full flexion at the ankle, but to stop when about half the normal degree of movement has been gained, this being quite sufficient for all the ordinary purposes of walking, running, etc.

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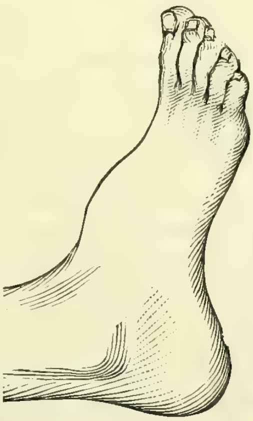
[1] Anatomically its posterior surface; but to avoid confusion in this description, anatomy is disregarded, and the position of the patient rules the terms as to direction.

Treatment by Manipulation.—The treatment of paralytic equinus in which the Achilles tendon only so far limits movement by its contraction as to prevent the foot from being flexed beyond the right angle, is generally better conducted by mechanical and physiological measures than by tenotomy; such a course of treatment should always be first adopted with young children, or in cases in which there is much wasting of the limb, it being understood, of course, that there are present no other reasons, such as will hereafter be described, for resorting to tenotomy. The mechanical treatment consists in the use of a Scarpa's shoe in the same manner as when the tendon has been divided, only that the extension may be pushed on as quickly as can possibly be done without causing injury from the exercise of too much force. The physiological measures employed are daily flexion of the foot on the leg, which may be accomplished either by manipulation or by means of an instrument; if done by hand, an attendant holds the leg firmly, keeping the knee extended, and with the other hand flexes the foot as far as possible; he then relaxes and again flexes the foot, continuing the exercise for as long a period as may be thought advisable. The patient may himself conduct the same exercise by using an instrument constructed on the plan of Stromeyer's exercising board; this consists of a frame to which is fixed a trough for the leg; to the leg-piece is attached, by a free joint corresponding to the ankle, a contrivance to hold the foot, which is constructed very much like the foot-portion of an ordinary Scarpa's shoe; to the end of this is jointed a steel rod about two feet long and supplied with a handle; the leg and foot being fastened to this appliance, the patient by means of the rod works the foot-piece backwards and forwards, and so extends and flexes the foot on the leg. A still better method is for the patient to place the toe of the affected foot against the wall of a room, and, whilst keeping the foot flat on the floor, to endeavor to flex the ankle-joint as much as possible; then relax and again flex, taking care when so doing not to raise the heel from the ground. After employing this exercise for some days, the knee will probably be made to touch the wall; the foot must then be drawn back, and the distance be gradually increased until free movement has been established. The advantage of this method is that it is more interesting to the patient, as he is able to watch exactly the amount of progress made, whereas the mechanical exercise is rather monotonous, and on that account is often neglected. If, after a fair trial of one or all of these methods, the contraction of the tendon does not yield, tenotomy must be resorted to.

A case presenting well-marked characteristics of paralytic equinus, such as that above considered, serves as a standard as regards treatment with which to compare the modifications required in the management of other conditions of the deformity. In the table before given, three states of paralytic equinus are classified, each state being again separated into two groups according to the time that the deformity has existed. In the early stage of equinus, resulting from slight loss of power of the flexor muscles of the foot, the distortion is readily overcome by the use of the physiological method of treatment alone; if, however, this condition has existed for three or four years, it may be accompanied by some contraction of the plantar fascia with deepening of the sole of the foot. When this latter condition has been developed, division of the contracted band of fascia is the right course to adopt; there is nothing to be gained here by resorting to mechanical means, which may be successful, but which will take a much longer time to gain the desired result, while the division of the fascia cannot possibly be productive of ultimate harm. Should the Achilles tendon be contracted, even to such an extent that the foot cannot be flexed to a right angle with the leg, mechanical and physiological measures must first be employed; the desirability of not lengthening the tendon if it can be avoided is obvious, and moreover the risk of developing calcaneus is always present in these cases. Having reduced any distortion of the foot itself that may have existed, the use of the Scarpa's shoe is continued to overcome the shortening of the contracted muscles; if interference with flexion of the foot is only slight in degree, the constant use of the shoe is not necessary, but the child may be allowed to walk with a steel support attached to the foot, and with a flexion-spring to assist the weak anterior muscles and counteract the action of the extensors, the shoe being worn at night, and as many hours during the day as may be thought desirable. Exercise of the foot by one of the methods previously described, and the employment of galvanism and of shampooing to stimulate the paralyzed muscles, are also necessary parts of the treatment. When the loss of muscular power is more severe, the deformity in the early stage usually yields to the measures just described as suitable for the second stage of slighter paralysis; but if of some years' standing, and if the heel is drawn up, section of the Achilles tendon is required, always remembering that any shortening of the sole of the foot that has been caused must first be relieved. In the condition of complete loss of power of the anterior muscles, the early stage may be submitted to treatment without operation, but in the later stage operative measures must always be employed. Spasmodic equinus is treated on the same lines as those drawn up for the relief of paralytic deformity, but section of the tendo Achillis is always to be avoided if possible, and in no case should tenotomy be performed so long as the exciting cause of muscular contraction is at work.

Talipes Arcuatus.—In describing the characteristics of talipes equinus, frequent mention has been made of the existence of two conditions which contribute to the deformity—shortening of the foot with contraction of the plantar tissues, and extension of the foot on the leg from contraction of the posterior muscles. Both these conditions are dependent upon paralysis of the flexor muscles, the first arising from the front part of the foot falling down and becoming displaced from the astragalus and os calcis at the transverse tarsal joint, the other from elevation of the heel by the unbalanced action of the extensor muscles. The degree of each condition present varies considerably in different cases of the deformity: in one foot, the contraction in the sole is the chief feature; in another, the elevation of the heel is the most prominent symptom; it has therefore been proposed to distinguish between the two forms of talipes equinus by limiting the term equinus to the latter state of distortion, and to apply to the former the title of talipes plantaris.[1] I have not adopted this method of nomenclature, because the two conditions are nearly always associated together, although one may be greatly in excess of the other, so that, to be strictly accurate, the term equino-plantaris would have to be used in the majority of cases; this would fail to convey any clear definition of the exact nature of the deformity, or to point out which was the chief characteristic of any particular case. There is, however, a state of distortion of the foot which consists of contraction of the sole without any depression of the forepart of the foot, and with no interference with the position of the foot on the leg; it distinctly differs from talipes equinus in that the heel and toes are on the same level, and the only defect is increased deepening of the arch. This deformity is by no means an uncommon one, and from the fact that in its early stage it rarely attracts notice, unless the heightened arch is welcomed as a point of beauty, it is often allowed to advance until the subject becomes seriously crippled. As this condition cannot be classified with any of the other recognized varieties of club-foot, I have employed the term *talipes arcuatus* to distinguish the deformity, and to indicate the nature of the distortion.

Fig. 1470.



Talipes arcuatus.

An extreme instance of talipes arcuatus, occurring in a boy nine years old, is illustrated in Fig. 1470; the foot was 7½ inches long, and so much contracted in the sole that the centre of the arch was 1⅛ inches above the level of the heel and toes, whilst the middle of the outer border of the foot was raised ¾ of an inch; the instep was also very high; the movements of flexion and extension at the ankle-joint were quite normal.

Although talipes arcuatus seldom presents such a marked degree of distortion as is shown in this case, it is nevertheless an unmistakable condition of deformity; when brought under the notice of the surgeon, relief is generally sought from the discomfort produced by a row of corns along the front part of the foot, and from the occurrence of pain at the transverse tarsal joint; an examination of the foot reveals that the arch is abnormally long and high, so that the treading surface is much reduced in space. The deficiency in this latter respect is shown in the accompanying figures (Figs. 1471 and 1472) of two feet of the same patient, the right foot being affected with talipes arcuatus, and the left being normal; the loss of surface in the right foot is at the front of the heel, at the centre and inner border of the middle of the sole, and at the forepart of the foot, which is wider from side to side, but narrower from before backwards; the foot is also considerably shortened. The source of the deformity is not easy to discover, because the cases are seldom seen until the contraction has been present for some years. It is more frequently met with amongst the better class of people, and not uncommonly the subject has been attacked with scarlet fever at about the time at which the contraction may be supposed to have commenced; beyond these clinical facts there is nothing that I have observed which can clear up the question of etiology. Possibly the fact that the feet of children amongst the prosperous are more tightly constricted than amongst the poor, may contribute to the greater liability of the former to the affection. Muscular disturbance is a not unfrequent sequel of scarlet fever and other acute diseases in childhood, and contraction of the plantar muscles, so induced, may be the original cause of distortion of the foot; but with our present limited knowledge, these are at the best only speculative suggestions upon an obscure subject.

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[1] The name *talipes cavus* has also been used to distinguish this condition of deformity; but the word *cavus* is by no means a good one, as it signifies hollow like a tube.

Fig. 1471.

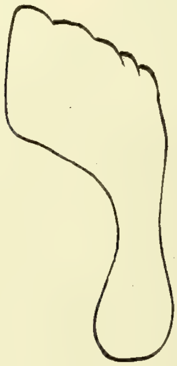


Diagram of foot in talipes arcuatus (¼ natural size).

Fig. 1472.

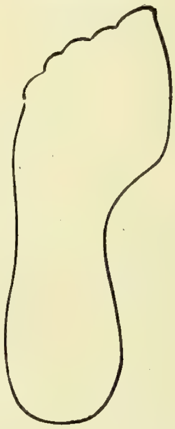


Diagram of normal foot (¼ natural size).

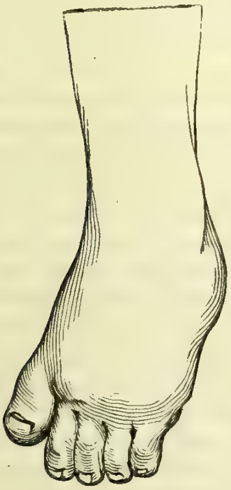
The *treatment* of talipes arcuatus is not attended with any difficulty, and the measures adopted are very similar to those already described as required for the relief of plantar contraction in talipes equinus. Section of the plantar fascia and of the superficial muscles of the sole of the foot, is necessary when the deformity has existed for a lengthened period of time; in the mechanical treatment, after operation, an apparatus somewhat similar to the foot-piece of a Scarpa's shoe is used, but a strap passing directly over the instep to each side of the sole-plate is required, to give resistance to the mechanical pressure brought to bear upon the heel and forepart of the foot; the reduction of the deformity should be carried on as quickly as is consistent with the careful application of the mechanical power of the instrument. The result of treatment is always satisfactory, for although complete removal of the contraction of the arch is not invariably obtained, the treading surface of the foot can be sufficiently enlarged to enable the patient to walk with perfect comfort. The case illustrated in Fig. 1470 was under treatment for two months, and at the end of that period the outer margin of the foot was brought level with the heel and toes, and the plantar surface was greatly increased; in the other case of which diagrams are given, that of an adult, there was no difference in the length of the two feet after three months' use of the shoe; in both cases the contracted tissues in the sole of the foot were divided.

Talipes Varus.—Talipes varus, like the other varieties of club-foot, occurs both as a congenital and as a non-congenital affection; the congenital form is by far the most common, and possesses especial interest for the twofold reason that it is the most severe in its nature, and the most difficult to cure, of all the distortions of the foot.

Congenital Varus.—This presents many degrees of distortion, but the characteristic features of the deformity are that the foot is adducted, inverted, and extended: the adduction and inversion consist chiefly of displacement of the forepart of the foot from the astragalus and os calcis; the extension is mainly due to altered relationship of the foot with the leg. The forepart of the foot is so changed in position that the sole is turned backwards, and the dorsum forwards, and that the toes point directly inwards; the inner border is twisted upwards, and forms about a right angle with the inner surface of the leg; the outer border is directed downwards. The heel is raised, and is unnaturally small in size; the outer malleolus is unusually prominent, whilst the inner malleolus is partially hidden by the inverted foot, and is also often ill-developed. The integument of the foot is implicated in the deformity; on the inner border it is tense and shiny in appearance, bearing some resemblance to cicatricial tissue, and there is frequently a deep sulcus which runs into the sole of the foot and corresponds to the position of the transverse tarsal joint; along the outer border, and on the dorsum, the skin is loose and apparently over-abundant, whilst at the heel, usually on the inner side and just above the insertion of the tendo Achillis, there occurs a second sulcus with contraction of the superficial tissues.

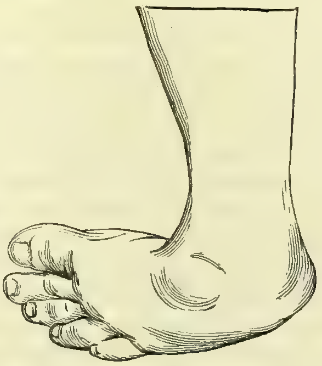
From the above description it will be seen that congenital varus consists really of the combined forms of varus and equinus; the extent to which these conditions of deformity may exist is, however, very variable, as may be observed from an examination of the following figures, taken from casts of the distortion. Fig. 1473 illustrates a condition of slight varus with an extreme degree of equinus, the deformity here consisting chiefly of extension of the foot on the leg; Fig. 1474 shows a marked state of varus with but little elevation of the heel, the principal distortion being at the transverse tarsal joint; Fig. 1475 represents a severe degree of both varus and equinus.

Fig. 1473.



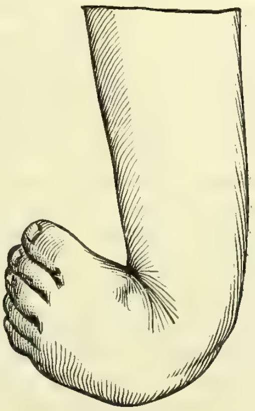
Congenital talipes varus with extreme equinus.

Fig. 1474.



Congenital talipes varus with extreme varus.

Fig. 1475.



Congenital talipes varus with severe equinus and varus.

Anatomical Changes in Congenital Varus.—The changes in the anatomical structure of the foot which occur in congenital varus, consist in an alteration in position and shape of some of the bones, together with an abnormal condition of the ligaments. Of the *bones*, the os calcis is affected chiefly as regards its position, which is so changed that the long axis of the bone, instead of being horizontal, is directed vertically, the posterior surface pointing upwards and a little outwards, whilst the anterior surface is turned downwards and slightly inwards; in shape the bone is not altered. The astragalus is thrown forwards and downwards, so that its superior articular surface, which is normally in direct relationship with the under surface of the tibia, appears on the dorsum of the foot, while the anterior articulating surface, which enters into the formation of the astragalo-scaphoid joint, is directed downwards and inwards; the inward direction of the head of the bone is contributed to by the neck being slightly twisted that way, an interesting change in the shape of this bone which was first described by Adams.[1] The scaphoid bone is greatly displaced: not only does it follow in direction the head of the astragalus, but it is still further pulled away from the articular surface thereon, in a direction upwards, inwards, and backwards, so as to be brought into apposition with the internal malleolus; the anterior surface of the scaphoid thus points inwards instead of forwards, and its posterior surface outwards instead of backwards; the tubercle on its inner surface is also directed upwards, and its outer surface is turned downwards. The other bones of the foot—the cuboid, cuneiform, and metatarsal bones—merely adapt themselves in position to the changed situation of the os calcis and scaphoid.

The *ligaments* are naturally affected by the marked change in the shape of the foot; their points of attachment are, according to their position, either more closely brought together or unduly separated; the former is the case with the deltoid or internal lateral ligament, the plantar fascia, and the calcaneo-cuboid and calcaneo-scaphoid ligaments of the sole; as a consequence, these ligaments are all shortened and contracted, while the astragalo-scaphoid ligaments and the anterior ligament of the ankle-joint are stretched and weakened.

The *muscles of the leg and foot* are generally well developed in cases of congenital talipes varus, but those which by their action extend and adduct the foot upon the leg are structurally shortened and contracted. The gastrocnemius and soleus muscles are in this respect affected to a degree which corresponds to the amount of equinus existing in the particular case of deformity; when the heel is much raised, the tendo Achillis is firmly contracted and somewhat displaced to the outer side of the leg. The tibialis posticus and anticus muscles are shortened to an extent depending upon the amount of inversion and adduction of the foot which is present; the former is usually very tense, and its tendon is considerably displaced, for, owing to the changed position of the scaphoid bone, it passes directly downwards to its point of insertion; the tibialis anticus is also affected in the same manner from the altered situation of the cuneiform bones, and its tendon is deflected considerably to the inner side of the leg and foot. The other muscles of the leg present no peculiarities deserving especial notice except in cases of severe deformity, when the extensor proprius pollicis is somewhat contracted, while the extensor longus digitorum and peronei muscles are small and ill-developed.

Etiology of Congenital Varus.—Much difference of opinion has existed amongst authorities as to the etiology of congenital varus: the principal theories of causation that have been advanced are, the influence of maternal impression, the pressure of the uterus, arrest of development, and the existence of nervous disturbance. The influence which *maternal impression* may have upon the fœtus has often been discussed, but, although cases have been quoted in support of the sympathetic development of certain abnormalities, little more has been proved than can be explained by the laws of coincidence. Even supposing that in a certain number of cases the evidence of mental disturbance is to be traced, nevertheless, in the large majority of instances, no such history is given; again, the mother's account must always be received with some suspicion, for, regarding the club-footed infant as a reflection upon her constructive abilities, she eagerly catches at the somewhat poetical idea of having received a shock during pregnancy upon seeing some unfortunate cripple, and thus satisfactorily relieves herself of all responsibility in the matter.

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[1] Op. cit., page 152.

In support of the theory that congenital varus results from *pressure of the uterus*, it has been argued that the natural position of the feet of a fœtus corresponds to the abnormal condition of deformity; and that if from deficiency in amount of the liquor amnii, or other cause, the fœtus is unduly pressed upon, congenital varus is established. If this explanation were correct, the lower extremities would also participate in the deformity, and would retain the flexed position which they had assumed *in utero;* moreover, the greater the distortion of the foot the more severe would have been the pressure of the uterus, and even supposing that the fœtus was able to live under such a condition, there would of necessity be developed a corresponding state of deformity in other parts of the body. That *arrest of development* has any productive effect in the origin of varus, is disproved by the fact that the feet are usually abnormal only in shape, and that, except in severe cases, there is no defect in tissue-formation of the bones, muscles, or ligaments. Deformity of the foot is occasionally the result of arrest of development, but such cases are comparatively rare, and when so produced the distortion is always accompanied by very distinct evidence of defective construction, such as the absence of one or more toes, smallness of the limb, and similar conditions.

It is in the existence of *disordered nervous influence*, and consequent muscular disturbance, that we must seek for the cause of congenital club-foot. And here the question arises, From what form of nerve lesion does the deformity originate? Is it from loss of nerve-function with paralysis of the muscles, or from nerve-irritation with spastic muscular contraction? Undoubtedly the weight of evidence is strongly in favor of the latter theory. In support of the theory that paralysis of the muscles which flex and abduct the foot—the extensors of the toes and the peronei—first occurs, and that the extensors and abductors overpower their weakened opponents and so cause the deformity, it has been urged that the distortion can easily be reduced soon after birth by drawing the foot into its normal position, and by thus giving assistance to the feeble muscles. In slight cases of deformity the foot can be thus readily placed in position, and in such cases the child when stretching out the legs exerts sufficient muscular power to overcome the distortion; but if the muscles were paralyzed, it would, from the very nature of their condition, be impossible for them under any circumstances to overcome their more powerful opponents, whilst if the ease with which the deformity could be overcome were to be taken as a sign of paralysis existing, then no matter to what degree distortion had been developed, reduction should be effected with equal facility in all cases, because in all the resisting force would be the same. The theory that spasmodic contraction of the gastrocnemius, soleus, tibialis posticus and anticus muscles, is the cause of congenital club-foot, is supported by the fact that these muscles are always more or less firmly contracted, and that the degree of resistance to reduction of the deformity is directly proportionate to the amount of muscular shortening which is present; moreover, the displacement of the bones exactly corresponds to the effect which would be produced upon the foot by abnormal contraction of these several muscles; further, of the non-congenital varieties of talipes varus, that arising from spasmodic muscular contraction bears a much greater resemblance to the congenital form than does that resulting from paralysis; and again, paralytic equinus is the most frequent of the acquired forms of club-foot, and the most uncommon of all congenital deformities. In describing the causation of non-congenital club-foot, it was noticed that the earliest cause acting after birth was irritation of the nerve-centres; and it is not unreasonable to suppose that the fœtus is especially liable to the same nerve-excitation, and that during the period of development *in utero* the nervous tissue is particularly sensitive to morbid influences. If this deduction is correct, we should expect to find spastic muscular contraction and deformity complicating cases in which there is defect of development involving the nervous system; and such is in fact the case, for in the anencephalic fœtus, and in those affected with spina bifida and other malformations implicating the nerve-centres, there is often present the condition of club-foot. The case of varus illustrated in Figure 1475 occurred in a child who was also affected with congenital deformity of the spine. The column presented somewhat the same condition that arises from extensive caries of three or four of the bodies of the vertebræ, with greater destruction on one side than on the other, and with the formation of severe angular deformity combined with lateral displacement; both feet were distorted to an extreme degree, and the muscles were very rigid. No doubt there had been, in this case, arrest of development of the bodies of the vertebræ, and local irritation of the spinal cord had been present; for some few weeks after birth the child was subject to clonic spasms of the muscles of the lower extremity, which prevented any treatment being undertaken for the relief of the deformity of the feet. The child is still under observation, being now seven years old; the varus is quite cured, but from the deformity of the spine she is not taller than a well-made child of two years.

Treatment of Congenital Talipes Varus.—The treatment of congenital varus is divided into two stages: first the foot itself is restored to its natural form, and afterwards the elevation of the heel is overcome and the normal position of the foot with the leg is obtained; the reasons for following this course are similar to those already explained in describing the treatment of talipes equinus; the inversion and adduction of the foot depend upon displacement of the bones at the transverse tarsal joint, and hence this defect is more easily removed by retaining the immobility of the os calcis and astragalus, whilst proceeding to place the anterior portion of the foot in position. The muscles which have by their contraction induced, and which by their shortened condition maintain, the inversion and adduction of the foot, are the tibialis posticus and tibialis anticus; and in commencing treatment, the first point to be decided is whether or not section of the tendons of these muscles is necessary. In cases in which the distortion of the foot exists only to a slight degree, such as that illustrated in Fig. 1473, tenotomy is not required; but when the deformity is more severe, and the foot firmly resists all attempts to restore it to its proper position, section of the tendons must be performed.

Subcutaneous division of the *tendon of the tibialis posticus muscle* presents some difficulties, because it is deeply situated, and, especially in a fat child, is not readily detected. The patient is so placed that the inner surface of the leg looks directly upwards, and that the anterior surface is turned away from the operator. An assistant steadies the limb by holding the foot and leg, and a sharp-pointed tenotome is entered about three-quarters of an inch above the ankle, exactly in the centre of the inner surface of the leg; it is pushed on until the edge of the tibia is reached, the sheath of the tendon being freely opened by a few strokes of the blade. The sharp-pointed knife is then withdrawn, and one with a blunt point is entered through the puncture, slipped through the opening made in the sheath, and passed between the tendon and the bone; the flat side of the blade has been so far kept towards the tendon, but the cutting edge is now turned, and, the assistant abducting and flexing the foot to render the tendon tense, a few strokes of the knife readily effect its division.

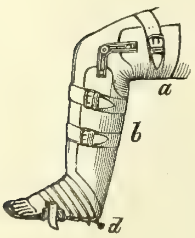
The *tibialis anticus tendon* is next divided, the point selected being just in front of the ankle-joint; and in seeking for this tendon it must be remembered that it is displaced to the inner side of the leg. The child is turned slightly over on his back; a small, sharp-pointed tenotome is entered on the outer side, so as to avoid the dorsalis pedis artery, and passed beneath the tendon; this is always considerably contracted, and, on turning the cutting edge of the knife, is usually divided by simple pressure; the assistant should slightly extend the foot, but should not exercise any force, as from the length of this tendon the divided ends separate very much after the section is completed. The small wounds made during the operations are closed with pads of lint directly after the knife has been withdrawn; the leg is then carefully bandaged; and a flexible splint, bent to a degree corresponding to the original condition of deformity, is fixed to the leg and foot.

The division of the tibialis anticus tendon is an operation which presents no difficulty; the only practical points deserving notice are, first, that the knife must be entered on the outer side of the tendon, as otherwise the dorsalis pedis artery is almost sure to be cut, and secondly, that the assistant must not make too forcible extension of the foot, for this little tendon flies asunder so readily that the knife is liable to be jerked through the skin, making an open wound. The section of the tibialis posticus tendon is not so simple a matter, on account of the depth at which it is situated, and of the close proximity of the posterior tibial artery. It is probable that this vessel is not unfrequently wounded by those not well practised in the method of dividing the tendon: no harm is likely to result if the artery is cut completely through when severing the tendon with a blunt-pointed knife; but if it be pricked with the sharp-pointed tenotome, a traumatic aneurism will probably be formed. I believe that I have divided this artery on two occasions; at any rate, on withdrawing the knife a spurt of arterial blood issued through the puncture in both cases; pressure was applied, and maintained by pads of lint for six days, and no harm followed upon the accident. In these operations the blunt-pointed tenotome was used; both of the children were puny little infants with very small legs. In robust, well-developed children, the use of the blunt-pointed knife is not so necessary, because the distance between the artery and tendon is greater; it is however safer to use the blunt tenotome if the operator is not often in the habit of performing the operation. The section of the tendon is not plainly recognized when completed, as in the case of the tibialis anticus tendon, and this difference is due to the fibres of the posterior muscle being prolonged down to the point at which the section of the tendon is made; for this reason, care must be taken to effect the division as low down the leg, and as near the ankle, as can be done without risk of injuring the posterior tibial artery. The inner border of the tibia is the guide by which the tendon is found; the sharp-pointed tenotome will strike this part of the bone if it be entered exactly in the middle line of the leg; if the proper spot be missed, a little careful manipulation, using the point of the knife as a probe, will find the edge of the bone; the sheath of the tendon is then opened, and when the blunt-pointed knife is passed through this and between the tendon and the bone, it will be held firmly between those structures, and the operator may feel assured that the blade is in the right position for completing the section.

The reduction of the inversion of the foot, in a case of moderate severity, usually takes about three weeks to accomplish. The method of treatment employed is very simple; a flexible metal splint, well padded on one side and sufficiently long to reach from the knee to half an inch below the toes, with some soft narrow bandages, are all the mechanical appliances required. After the operation the foot is kept at rest, and in the state of deformity which was present before the tibial tendons were divided, for five days, at the end of which time the small punctures are quite healed; the leg is then covered with a bandage from the toes to the knee, and the splint, bent at a point corresponding to the ankle-joint, is placed on the outer side of the leg, and fixed by rolling the bandage around it and the limb, from the calf to the end of the toes. By gradually straightening the splint from day to day, the foot is brought out until it is in a line with the leg, and as soon as it will remain in this position without support, the case is converted into one of equinus, and the second stage of treatment may be entered upon. In cases of severe distortion, four or five weeks are required to overcome the inversion of the foot, and in no case should the treatment of the equinus be commenced until the distortion of the foot is completely relieved. Some surgeons, in slight cases of congenital varus, divide the Achilles tendon at the same time as the tibial tendons, but beyond saving a little time in the treatment of the case, no advantage is gained by this method of procedure; on the other hand, there is always the possibility of the distortion of the foot itself not yielding as readily to treatment as was at first anticipated, and should such happen in a case in which simultaneous section of the three tendons has been performed, the difficulties of treatment will be much increased; it is in my opinion much safer to divide the operation into two stages, in all cases of congenital varus which are sufficiently severe to require tenotomy at all.

The *second stage* of the operative treatment adopted in congenital varus is the same as that already described for the treatment of talipes equinus, but the mechanical measures employed are not quite the same, for it is not only necessary to overcome the extension of the foot on the leg, but care must also be taken to maintain the foot in its improved shape, and to prevent it from becoming again inverted. For the instrumental treatment of varus in this stage, many different sorts of appliance have been invented and used with success; the particular form of instrument is of no great consequence, provided that it is so designed as to enable the foot to be gradually flexed on the leg, and at the same time to prevent its relapsing to the condition of inversion. The splint which best fulfils these requisites is one introduced by Mr. Adams, and illustrated in Fig. 1476; it consists of thigh and leg trough-pieces, *a* and *b*, connected by a free joint at a point corresponding to the knee; to the leg-piece is attached a plate for the foot, with a cog-wheel at *d*, which supplies the movements of flexion and extension; a toe-wire with a strap is fixed to the front part of the foot-plate on its outer side. The method of applying this apparatus will be best understood by studying the drawing; the same manner is followed of first fastening the heel, and then the thigh and leg, before placing the front of the foot in position, as has already been described when treating of the mode of applying Scarpa's shoe in the treatment of talipes equinus; with congenital varus, the further precaution has to be observed of keeping the sole of the foot well extended, and the inner border quite straight, by drawing the toes over to the outer side of the instrument, with the strap and toe-wire.

Fig. 1476.

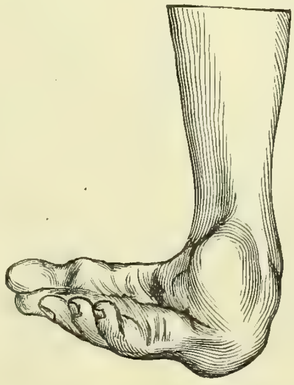


Adams's varus splint.

The most favorable time for commencing treatment is when the infant is about six weeks old, but much depends upon the condition of the patient: in a robust, healthy child, an earlier commencement may be made, while in a weak infant treatment should be delayed; from two weeks to three months may be estimated as the limit of age in the respective conditions. After the deformed foot has been restored, the use of the instrument must be continued until the child is able to walk, when a light steel support, fixed to the boot, will be required; in slight cases, a bar extending to the calf on the inner side of the leg, with a free joint at the ankle, and a strap attached to the boot so as to brace up the foot against the support, is sufficient to keep the foot in good position when walking; in cases of more severe deformity, the instrument must be extended to the thigh, or if necessary to the waist, to overcome any tendency to adduction of the limb which may be present. The shoe must be worn at night, and instrumental treatment continued, until the foot is perfectly restored to the normal state; although a difference of opinion still exists as to whether spasmodic contraction of one set of muscles, or paralysis of their opponents, is the exciting cause of congenital varus, few surgeons will dispute the fact that an abnormal condition of the muscles is the source of deformity, and the supporters of either of the two theories must be in accord upon one point, viz., that until the muscles are restored to a normal condition the exciting cause of distortion still exists, and will to a certainty, if not counteracted, reproduce the displacement of the foot. It must therefore be accepted as an established rule, that the treatment of congenital varus is not successfully concluded until the subject is able to walk with the foot everted, and with the plantar surface placed well on the ground.

Congenital Varus in Advanced Life.—Congenital varus, when not relieved in infancy, becomes with advancing age greatly increased in degree; and this is probably due, not as much to shortening of the contracted muscles, as to the mechanical effects of pressure brought to bear upon the foot when used in standing and walking. The structural defects in a case of advanced varus are of the same nature as those already described as existing in the infant, but they become aggravated by time, and are more firmly established; the growth of the foot is checked, and the tarsal bones are badly developed, their articular surfaces being also very irregular in shape and position. The os calcis, in addition to an increase in the vertical direction which it assumes in the infant, becomes changed in shape from arrested growth of the greater tuberosity; the displacement of the astragalus from the tibia is more marked, and the head and neck of this bone are small in size, whilst the latter is still further deflected inwards; the articular surface on the outer side of this bone is separated from the external malleolus, and that on the inner side is imperfectly developed. The scaphoid bone is the most seriously displaced of all the tarsal bones, its position being the same as in the case of infantile deformity, but its abnormalities in this respect being much exaggerated; the cuboid bone is dragged inwards and partially dislocated from the os calcis; the cuneiform bones retain their places on the scaphoid; and the metatarsal bones, which follow them and the cuboid, are much pressed together. The ligaments are seriously implicated in the deformity; the plantar fascia and calcaneo-cuboid and calcaneo-

Fig. 1477.



Advanced congenital varus.

scaphoid ligaments, which are shortened at birth, become so firmly contracted that they offer the chief obstacle to reduction of the deformity.

The external appearances presented by a case of advanced varus correspond to the changes which occur in the structural shape of the foot; Fig. 1477 illustrates the foot of a boy aged six years, in whom congenital varus had been allowed to continue its course without the employment of any form of treatment for its relief. The parents of this boy were shown casts of the varying conditions of varus in its early stage, and selected one of quite a moderate degree of severity as showing a deformity similar to that which had existed in their son's foot at birth; in a comparatively short time, the distortion had reached the extreme condition illustrated in the drawing, which clearly indicates the great importance of overcoming congenital varus at as early a period of life as possible.

The features exhibited in this case were quite characteristic of those usually presented in advanced varus: the heel is much raised, and the tendo Achillis is in prominent relief and firmly contracted; below the heel, on the part of the foot which has been used in walking, is a large pad of thickened skin and cellular tissue, which supplies the place of the normal heel; this pad, when the deformity of the foot has been reduced by treatment, becomes situated on the upper surface of the dorsum, at about the seat of the cuboid bone. Running across the sole of the foot from its inner border, is a depression which corresponds to the transverse tarsal joint, and which arises from shortening of the foot and contraction of the plantar fascia; another groove, which passes forwards from this to the great and second toes, is caused by the folding together of the metatarsal bones; and the front portion of the foot, from the same cause, presents a peculiar, twisted appearance. The condition here represented is by no means the ultimate state of deformity; as age increases, the distortion advances, but the characteristics are of the same nature and differ from those above noticed only in degree. A further complication exists in these cases from the extreme wasting of the muscles; this is owing to their want of use, for, since the foot is almost immovable on the leg, these muscles are never called into action.

The *treatment* of varus existing at a later period of life is carried on in the same manner that is followed in infantile cases; but it is necessary in this more severe condition of the deformity to divide the course of treatment into three stages; in the *first stage* the foot is brought in a straight line with the leg, in the second the contraction in the sole of the foot is overcome, in the third the elevation of the heel is reduced. It is of course always necessary to have recourse to tenotomy, and, as in the case of infantile varus, the tendons of the tibialis posticus and tibialis anticus muscles are first divided. The mechanical after-treatment is conducted on a similar plan to that already described, and by means of an outside splint attached to the leg the inversion of the foot is gradually reduced; this part of the treatment cannot however be always successfully accomplished by mechanical extension alone, and when after six or seven weeks' employment of the splint it is found that the foot still firmly resists the constant pressure that has been brought to bear upon it, it is necessary to have recourse to manipulative exercises, or, as it is technically called, *hand-working*, to overcome the condition of inversion. The resisting structures which have to be dealt with are the shortened and contracted ligaments which connect the os calcis and astragalus with the scaphoid and cuboid bones; these, from their situation, are of course not amenable to operative measures.[1] The method of working the foot is very simple; supposing that the right foot is under treatment, the heel is grasped firmly with the left hand, the fingers being on the inner side and the palm of the hand pressed against the outer surface of the os calcis; the front of the foot is held by the extremities of the metatarsal bones, and then steadily dragged outwards as far as possible, again relaxed and brought over, and so on, as long as may be thought desirable; no pain should be given by using too much force, and the exercise must be slow and methodical. The value of these manipulations in reducing severe inversion of the foot is very great, whilst from their extreme simplicity they can easily be practised by any person possessed of ordinary intelligence. It may happen, in severe cases, that the inversion of the front of the foot is contributed to by contraction of the plantar fascia; if this is the case, the resistance offered by the fascia, when endeavoring to evert the foot in the manner above described, will be readily detected, and the complete reduction of the inversion will have to be obtained during the second stage of treatment.

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[1] [R. W. Parker has, however, recently recommended and successfully practised subcutaneous section of the inner tarsal ligaments, and particularly of the astragalo-scaphoid.]

The *second stage of treatment* is commenced by dividing the contracted tissues in the sole of the foot in the manner already described when discussing the treatment of the first stage of talipes equinus; the instrument used in the mechanical treatment after operation is of the same pattern as the Scarpa's shoe employed in cases of equinus, but the front part of the sole-plate is supplied with two additional cog-wheels, one which moves it from side to side, and another which rotates it so that either side of the plate can be raised or depressed. In applying the instrument, the sole-plate is set to correspond with the deformity; by means of one cog-wheel it is lowered to a degree equal to the shortening of the sole, by the second it is turned inwards to accommodate it to the amount of inversion that may be present, and by the third the inner border is raised to the extent of rotation that is required; the heel-piece is next adjusted to suit the condition of equinus that exists. Having applied the instrument to the limb, first fastening the heel, then the leg, and finally the front of the foot, the three cog-wheels in the sole-plate are brought into use to draw the forepart of the foot, as much as can comfortably be borne, towards its natural position. This method of procedure is steadily carried on until the scaphoid and cuboid bones, together with the parts in front, are placed upon the astragalus and os calcis; here again manipulations are of great service in overcoming any deep-seated contraction that does not readily yield to the pressure exerted by the shoe; the foot is held in the manner previously described, and is worked in any direction that may be found necessary; if inversion is the chief feature of deformity still existing, the front of the foot is drawn outwards; should the front of the foot remain depressed, it must be steadily forced upwards; if the outer border is on a lower level than the inner, a twisting movement is required. These manipulations are only applicable to contraction of the ligaments directly connecting the several bones, and the surgeon must assure himself that it is upon this contraction, and not upon shortening of the superficial tissues, that resistance to reduction of the deformity depends; it not unfrequently happens that section of the plantar fascia requires to be repeated a second, or even a third, time in varus of long standing and of severe grade. This second stage of treatment is the most important part in the management of the case; every endeavor must be made to render complete the reduction of the displaced bones in front of the os calcis and astragalus, and thus to restore the shape of the foot itself, before proceeding to overcome the condition of deformity existing at the ankle-joint.

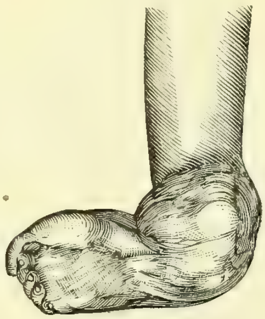
The *third stage of treatment* of advanced varus is practically the same as the second stage of that employed in talipes equinus, so that the account already given need not be repeated; it may be noticed, however, that, being a congenital deformity, the articular surfaces have not been properly developed, and that therefore the reduction of the deformity at the ankle-joint in the case of varus is not as readily accomplished as it is in acquired equinus, where the joint surfaces are but little affected.

Relapsed Varus.—It not unfrequently happens, especially amongst the class of patients who are treated at hospitals, that congenital varus which has been relieved during infancy, again becomes developed at a later period of life. The necessity for counteracting the tendency to relapse which is present until the normal condition of the muscles of the leg and foot is fully restored, has already been alluded to; it is however not always possible to impress the parents of a child, in whom the deformity has been relieved, with the fact that the cure is not yet completed, and the after-treatment of the case is thus often neglected. To such cases only can the term relapsed varus be correctly applied, but under this title are usually included all conditions of deformity which have been treated in infancy and still exist at a later age, so that cases which have never been completely relieved are improperly described as relapsed cases. Failure in the treatment of varus during infancy may depend upon mismanagement of the operative treatment, or upon want of attention to the instrumental treatment; in the former case, it may be due to tenotomy not having been had recourse to when required to relieve the contraction of the several muscles, or from section of the tendons having been imperfectly performed. Failure arising from defective management of the instrumental treatment of the case results from the use of improper appliances, which are not adapted to maintain the foot in position during the process of restoration. In the treatment of these cases of persistent deformity, the measures employed must be selected according to the particular nature of the case and the age of the patient. The condition of true relapse, if again submitted to treatment at an early age, is readily overcome by mechanical and physiological measures alone; but if some years have been allowed to intervene, tenotomy will probably again be required. Cases which have been only partially relieved from neglect to divide the tendons of the contracted muscles, are always amenable to treatment, which is conducted in a manner precisely similar to that given for the treatment of advanced varus. The most unfavorable condition which the surgeon has to encounter is that resulting from badly conducted operative treatment in the first attempt to relieve the deformity, because in such cases the tendons have usually been hacked about, and instead of uniting cleanly have become adherent to the surrounding tissues. These cases require much care in their treatment; it is not often that recourse to tenotomy is of any avail, but benefit may be gained by section of the plantar fascia, if the foot is much shortened. The adhesions which connect the tendons of the contracted muscles to the surrounding tissues may be stretched by long-continued instrumental treatment combined with manipulative exercises, and in these cases the latter method is a most valuable agent in reducing the deformity; by steadily pursuing this plan, I have restored many cases in which the leg and foot were almost covered with scars, from frequent attempts made to overcome the distortion by dividing the tendons.

Non-congenital Varus.—The development of talipes varus as a non-congenital affection may originate either from paralysis or from spasmodic contraction of the muscles of the leg and foot, the former being by far the most common form of the malady.

Paralytic varus, in its general character, presents the same condition of displacement as is found in the congenital variety, but there is a marked difference in the appearance of the two forms: in the congenital, the foot is rigidly jointed to the leg and exhibits no indication of weakness; in the non-congenital, it is as it were crumpled up, and looks as though it had been compressed out of shape from mere inability to hold its natural position. The character of the deformity is shown in Fig. 1478; in comparing this case with that of advanced congenital varus, Fig. 1477, page 1025, it will be observed that the paralytic foot is more displaced at the ankle-joint, but not so much distorted in itself; the cause of this difference depends upon the method of development in the two cases. In congenital varus, the distortion commences at an early period of fœtal life, and the bones of the tarsus are dragged out of place by active muscular contraction; in paralytic varus, the flexors and eversors of the foot are deprived to a greater or less extent of their contractile power, and the foot falls into a state of extension and inversion which gradually becomes established as a confirmed deformity, from the pressure brought to bear upon the foot in standing and walking.

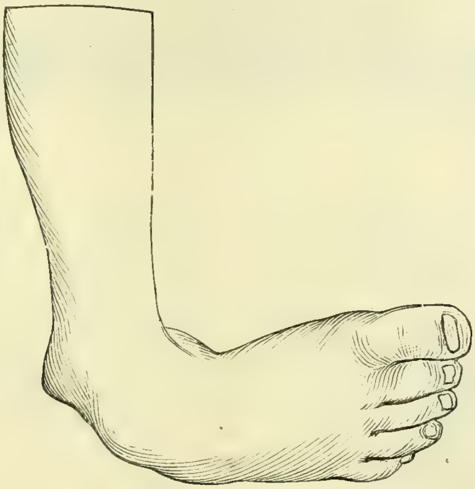
Fig. 1478.



Paralytic varus. (After Adams.)

Non-congenital talipes varus, the result of *spasmodic muscular contraction*, is more nearly assimilated to congenital varus than is the paralytic condition of distortion. Fig. 1479 is taken from a cast of the foot of a boy aged eleven years, who was affected with spasmodic varus; the case presents nothing of the feebleness which is so marked in the paralytic condition, Fig. 1478, but it so far differs from the case of advanced congenital varus, Fig. 1477, that the distortion of the foot itself is less severe, this, as in the paralytic variety, being due to the fact that the deformity is developed at a period of life when the formation of the foot is fairly advanced.

Fig. 1479.

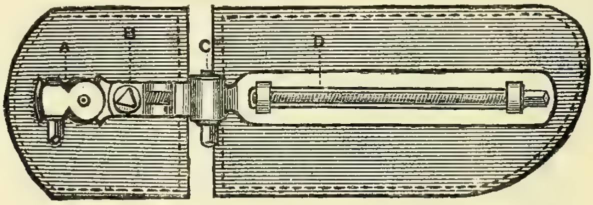


Spasmodic varus.

Treatment of Non-congenital Varus.—In treating non-congenital varus, the same measures are employed as in the reduction of the congenital variety. With regard to *paralytic varus*, the use of tenotomy must be guided by the same laws that have been given when describing the treatment of equinus. Varus the result of *spasmodic contraction* of the muscles, in which shortening of the muscular fibres has become confirmed, can only be relieved by section of the tendons; but in cases which are submitted to treatment in the early stage of the affection, mechanical and physiological methods are sufficient to overcome the distortion.

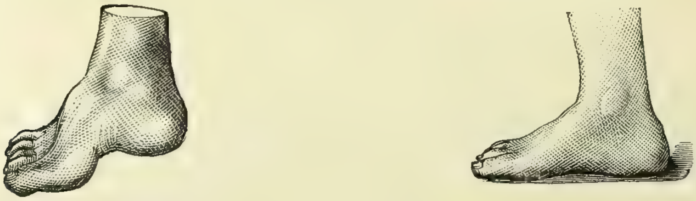
Extension in Treatment of Club-Foot.—In the two varieties of club-foot hitherto considered—talipes equinus and talipes varus—there is always present in severe cases of deformity a marked condition of structural shortening of the foot, with contraction of the plantar fascia; during the mechanical stage of treatment, the foot, in order to overcome this shortening, may be kept in a state of extension by drawing the forepart well forward on the sole-plate after the heel has been fixed, but with adult cases, where there is always great resistance to extension, some difficulty is found in retaining the foot in the required position. In order to effectually maintain a state of constant stretching, I have employed a shoe which is a modification of Adams's instrument. Fig. 1480 shows the under surface of this appliance; the sole-plate is divided at a point corresponding to the transverse tarsal joint, and is supplied with three cog-wheels, *A*, *B*, *C*, which respectively permit of the front part of the plate being moved laterally, raised, and rotated on the heel-piece; the power of extension is gained by the long screw *D*, on turning which the front plate slides forwards. In using the instrument, it must first be adapted to the condition of deformity by means of the cog-wheels in the sole-plate; it is then applied to the limb, being secured in the ordinary manner, and the front part of the foot is extended on the heel by turning the screw *D*. The patient is directly conscious of the stretching of the foot thus obtained, as he feels the foot give at the transverse tarsal joint, and he will be able to guide the surgeon in deciding how much extension it is desirable to use, this being to a degree just short of causing pain; having thus extended the foot, the front plate is next raised, rotated, and everted according to the necessities of the case under treatment. I have used this instrument

Fig. 1480.



Extension-shoe for club-foot.

Fig. 1481. Fig. 1482.



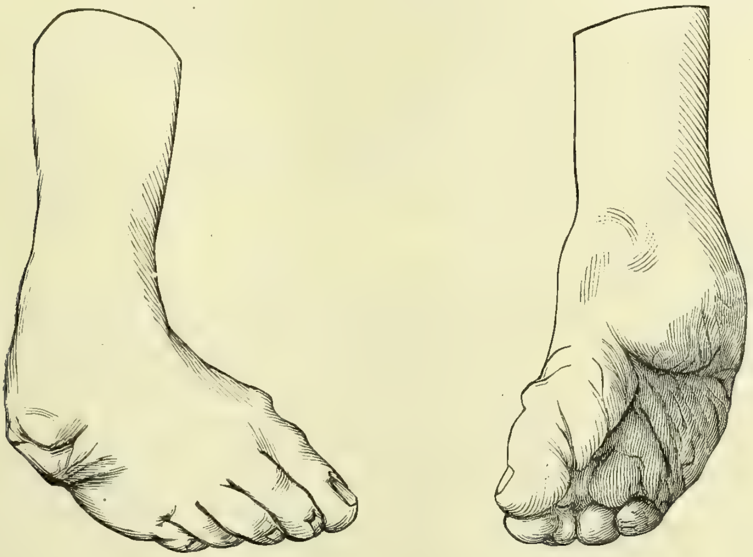
Severe equinus, before and after treatment.

for about four years, and believe that by means of its extending power I have been able to more quickly reduce the distortion of the foot; the two following cases will illustrate the therapeutic value of the instrument:—

Case I.—This occurred in a man, aged twenty-four, who had suffered in childhood from infantile paralysis which had resulted in the development of *talipes equinus* of the right foot. Fig. 1481, a drawing from a cast of the foot, shows the nature of the deformity when he was admitted into the National Orthopædic Hospital. The foot was very rigid, and firmly set in its abnormal condition; the sole was much shortened and contracted; and the instep was greatly raised. The plantar fascia was freely divided, and on the fourth day after the operation the extension instrument was applied; after eight weeks' treatment the distortion of the foot was completely reduced, the result being shown in Fig. 1482.

Case II. was one of *relapsed congenital varus*, in a girl aged 19; both feet were distorted, the right one to a remarkable degree. Figs. 1483 and 1484 show respectively the anterior surface and sole of this foot: the inversion of the foot was greater than is represented in these drawings, but unfortunately a cast which was taken of the foot before treatment was commenced, was not a faithful copy of the distortion, so that a second one had to be obtained after the foot had been operated on by division of the tibialis posticus and tibialis anticus tendons, and after about two weeks' use of the outside splint; the part of the foot which was placed on the ground is indicated by the partially absorbed pad in Fig. 1483, and from the position of this a fair idea is given of the amount of inversion which originally existed. Fig. 1484 is a three-quarter view of the sole: the compression of the foot was very marked; at the bottom of the sulcus, opposite the transverse tarsal joint, the surface of the skin was folded upon itself to the depth of a quarter of an inch; the forepart of the foot was greatly narrowed; and the metatarsal bones were much displaced. This was perhaps as severe a condition of relapsed varus as has ever been submitted to treatment; the usual course was followed of first overcoming the inversion of the foot, next reducing the contraction of the sole, and finally restoring movement at the ankle-joint. The whole time occupied by treatment was about fifteen months, the deformity of both feet being reduced in this period; some six weeks or so were lost, owing to the patient's suffering from an acute illness which

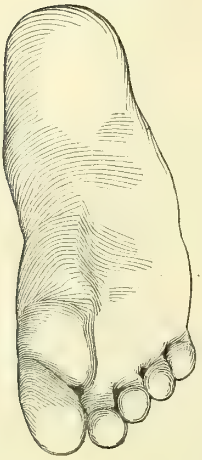
Fig 1483. Fig. 1484.



Severe relapsed congenital varus, anterior and posterior views.

necessitated the intermission of treatment; unfolding of the distortion of the foot itself was accomplished in seven months, which, considering the extreme condition of deformity present and the age of the patient, may be regarded as a satisfactory rate of progress. The result of treatment is shown in Figure 1485.

Fig. 1485.



Result of treatment in subject of Figs. 1483, 1484.

Excision of Tarsal Bones in Talipes Varus.—The method of treating talipes varus which has been described, is that generally followed by those who have studied the practice of orthopædic surgery; some slight differences of opinion exist upon certain details—when to employ tenotomy, the construction of the mechanical appliance used, the respective value of instrumental and physiological methods of treatment—on such points as these unanimity is not to be expected; but the broad principles of treatment are universally accepted, and hundreds of cases could be brought forward to prove that talipes varus, when thus treated, is capable of relief in whatever condition it may present itself. Successful reduction of the deformity can, however, only be obtained by careful observance of the established rules of practice; even at the present day, it is no uncommon circumstance to meet with cases in which tenotomy has been adopted, but in which the mechanical after-treatment has been entirely neglected, the patient being allowed to walk about without any support within a week or so of the operation, with the natural result of re-establishing the deformity. Again, cases which have been correctly and successfully treated are, from neglect of the patient or his parents to continue the use of mechanical treatment for a sufficient length of time, found to pass into a condition of relapse. The occurrence of relapse under such circumstances has raised a doubt in the minds of some surgeons as to the efficiency of orthopædic treatment, and more radical measures have been resorted to; it has been said that certain cases are not amenable to the recognized rules of practice, and for such exsection of a portion of the tarsus has been employed.

Excision of the *cuboid bone*, in severe cases of talipes varus, was first suggested by Dr. Little;[1] his suggestion was little more than a speculative observation, and this distinguished authority has since expressed his disapproval of the adoption of such an operation. The late Mr. Solly, in the year 1854, acting upon the above suggestion, excised the cuboid bone in an adult affected with severe varus, but the result was not satisfactory. Mr. Lund, in 1872,[2] excised the *astragalus* in a boy aged seven years, suffering from varus of both feet. The treatment employed before this operation was performed, had consisted in the application of splints and elastic bands, and forcible manipulation under chloroform. The operation was had recourse to under the belief that the chief obstacle to reduction of the deformity was the displacement of the cup of the scaphoid from the head of the astragalus; the case, after a prolonged course of treatment, resulted in the production of a tolerably straight foot, but with very limited movement at the ankle-joint and with persistence of some elevation of the heel. Mr. Davy has removed portions of the tarsus in several cases of club-foot, amongst them one of a child aged sixteen months,[3] an age at which few surgeons would pronounce varus to be incurable by tenotomy and mechanical treatment.

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[1] Deformities of the Human Frame, p. 305. London, 1853.

[2] Proceedings of the Medical Society of London, vol. iv. 1879.

[3] Ibid.

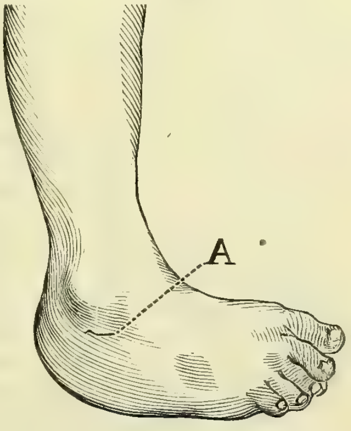
The most instructive case published, in which excision of a portion of the tarsus was performed, will be found in the Transactions of the Royal Medical and Chirurgical Society of London.[1] In this case, that of a boy aged 12 years with relapsed congenital varus of both feet, tenotomy and mechanical treatment were first employed, but these methods were altogether mismanaged; a properly constructed instrument was never used, and the plantar fascia, the tendon of the tibialis posticus muscle, and the tendo Achillis were divided at the same time. The chief interest of this case, however, lies in the fact that an enormous amount of the foot was removed before the deformity could be reduced; the cuboid, nearly all the scaphoid, portions of the three cuneiform bones, of the astragalus, of the os calcis, and of the two outer metatarsal bones were taken away, and even after this free excision of the bones of the foot, prolonged mechanical treatment was found necessary to keep what remained of the member in the required position.

The number of cases of club-foot which have been treated by excision of the tarsus may probably be numbered by tens: those treated according to the rules of orthopædic surgery can certainly be counted in thousands; of the former, two deaths have been recorded as resulting from the operations performed; of the latter, none have terminated fatally, nor has any complication of a serious nature been a source of trouble.

A reference to the reports of several cases in which excision of the tarsus has been performed, after tenotomy had failed to relieve the condition of varus, shows clearly that the deformity had proved to be intractable under a course of treatment which had been followed without regard to the established rules of practice. The error most frequently committed is that of dividing the Achilles tendon alone; also, in a large number of cases, the tendon of the tibialis anticus muscle is divided, but not that of the tibialis posticus; either no attempt is made to relieve the contraction of this muscle, or else the tendon is missed when performing the operation. Another fruitful source of failure is want of attention in conducting the mechanical treatment of the deformity after operation; it cannot be too strongly insisted upon that, in the reduction of club-foot, the operative treatment is of quite secondary importance to the mechanical, and that however skilfully tenotomy may be performed, a successful result will never be obtained unless the after-treatment be most carefully conducted.

The following case is an example of congenital varus in which tenotomy was had recourse to without relief, and in which, the deformity being thereupon pronounced to be intractable to milder measures, the tarsus was excised. W. H., aged 4, applied in the year 1879 to the Surgical Aid Society of London for a walking-instrument to correct a condition of varus of the right foot, for which he had been treated at one of the leading general hospitals from which he was just discharged. Fig. 1486, which is copied from a cast taken at the time, shows the condition of the foot; there were numerous scars of punctures over the tibialis anticus, tibialis posticus, and Achilles tendons, and on the outer side of the foot, below and in front of the external malleolus, was another scar about two inches long; this scar, which is marked *A*, is not well shown in the drawing, since, although it is indicated on the cast, it was but imperfectly copied by the plaster. The mother stated that the child had undergone several operations, and that finally some of the bones of the foot had been removed; as will be seen, a considerable degree

Fig. 1486.



Relapsed varus after excision of tarsus.

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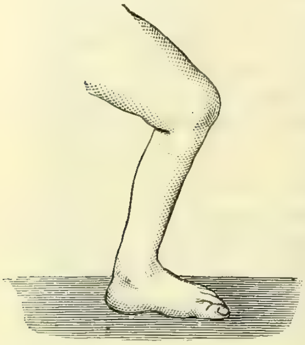
[1] Med.-Chir. Trans., vol. lx.

of deformity still existed, the foot being inverted and the inner border completely raised from the ground, while the heel was elevated, and both flexion and extension movements were very limited at the ankle-joint. The parents were naturally reluctant to try the effects of further treatment, but the child was finally admitted to the National Orthopædic Hospital. The case was managed in the ordinary way, and, although some difficulty was experienced in overcoming the immobility of the ankle-joint, the deformity was completely reduced after twelve weeks' treatment. The boy was kept under observation to ascertain if the reduction of the deformity was permanently established, but not the slightest tendency to relapse was evinced, and the condition of the foot, three years after treatment, was that shown in Fig. 1487, which is copied from a photograph. I have seen the boy again quite recently; the foot is in excellent position, and there is a very fair amount of movement in the ankle-joint.

Fig. 1487.



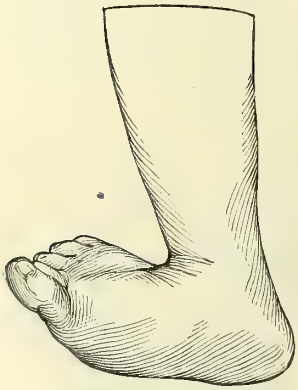
Same case as shown in Fig. 1486, after orthopædic treatment.

It is probable that excision of a portion of the tarsus may eventually be proved to be of service in the treatment of some conditions of severe congenital varus in the adult, but a more systematic method of performing the operation than has yet been defined must first be introduced; also, a more careful selection of the subjects for operation must be made, and above all, before resorting to the operation, the less severe measures of tenotomy and mechanical treatment must first be correctly employed. The case quoted above from the Transactions of the Royal Medical and Chirurgical Society of London, shows how large a portion of the tarsus may have to be removed before a straight foot (or rather portion of foot) can be obtained; the possibility of a fatal termination must also be considered; and, finally, it must be remembered that the victims of club-foot have often very fair powers of progression: the girl with double varus, whose right foot is illustrated in Figs. 1483 and 1484, walked so well that the condition of her feet would never have been suspected, and she submitted herself to treatment for relief from deformity, and not for the removal of lameness.

Talipes Valgus.—There are two distinct forms of talipes valgus, one of which may be either congenital or acquired, while the other is always non-congenital. The former condition is directly due to muscular disturbance; the latter is the result of defect in the ligaments of the foot, with which muscular contraction may or may not be secondarily combined.

The *congenital form of talipes valgus*, which is due to muscular disorganization and may be considered as true valgus, is, like congenital varus, a double distortion of the foot, and the combination here may be with either calcaneus or equinus. The appearances presented by a case of congenital valgus combined with calcaneus are represented in Fig. 1488: the outer border of the foot is raised and everted; the arch is wanting; indeed, the under surface of the inner border of the foot is convex instead of being concave in outline; the foot is flexed upon the

Fig. 1488.

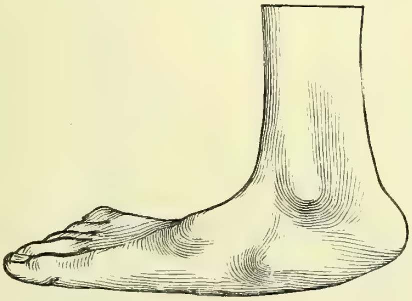


Congenital calcaneo-valgus.

leg, and the heel is depressed. The chief change in the position of the bones of the tarsus consists in displacement of the scaphoid and cuboid bones from the astragalus and os calcis: the scaphoid is dragged outwards and its inner border directed downwards; the cuboid is pulled outwards and upwards; the cuneiform bones, with the corresponding metatarsal bones, are depressed with the scaphoid; whilst the outer metatarsal bones are directed outwards and upwards with the cuboid; the varying position of these bones accounts for the peculiar twisted appearance presented by the foot. The development of this condition of distortion results from spasmodic contraction of the peronei and extensor muscles of the toes, the tibialis anticus muscle being also contracted in severe cases of the nature illustrated in Fig. 1488.

The variety of congenital valgus which is associated with equinus presents much the same twisted appearance as the above form of calcaneo-valgus, but the convexity on the inner border of the foot is still more marked; the heel is raised by contraction of the extensor muscles, the centre of the inner side of the foot is depressed from the changed position of the scaphoid, and the metatarsal bones on the outer side are elevated by contraction of the extensors of the toes; the normal condition of the foot, with reference to the parts of the sole which are placed on the ground, is thus almost completely reversed, for that portion which ought to form the arch is depressed, whilst the heel, the outer border, and the forepart of the foot, which ought to constitute the treading surface, are elevated; this condition of deformity is illustrated in Fig. 1489. In equino-valgus, the os calcis is more or less elevated according to the extent of contraction of the tendo Achillis, and its position becomes vertical to a corresponding degree; the superior articulating surface of the astragalus is thrown forwards on the dorsum of the foot, the head of the same bone forming a prominence on the inner side; the other tarsal bones are displaced in the same manner as in calcaneo-valgus.

Fig. 1489.



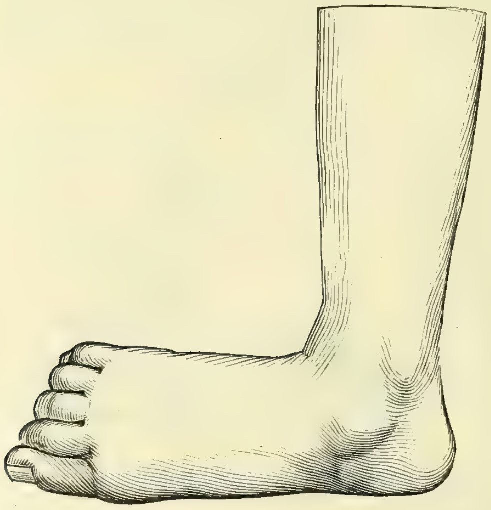
Congenital equino-valgus.

Congenital talipes valgus is a deformity which is not frequently met with, but when it does occur, the distortion is usually of a severe nature, the cases above illustrated being fair examples of the condition commonly developed. Congenital valgus, if allowed to continue unrelieved, interferes most seriously with the walking powers of the subject of deformity; the structural changes in the foot are of a much less complicated nature than are those present in congenital varus, but they nevertheless produce greater lameness, because the depressed arch of the foot, which is placed on the ground, is less able to bear pressure than is the dorsum, and also because the protecting pad of thickened skin and cellular tissue, which is developed in varus, is wanting in valgus.

In the *treatment of congenital valgus*, tenotomy is nearly always necessary; in calcaneo-valgus, the tendons of the extensors of the toes and the peronei muscles require division, and it may be also necessary to divide the tendon of the tibialis anticus. No especial directions are needed as to the method of performing section of these tendons: the peroneus longus and brevis are easily reached, and may be divided with one puncture, just above the external malleolus; the extensor tendons of the toes are directed a little in front of the ankle-joint, and for their section the tenotome is entered on the inner side of the proprius pollicis tendon; the method of performing tenotomy on the tibialis anticus tendon has already been described. Mechanical treatment may be commenced on the sixth day after operation; the reduction of the deformity must not be carried on too quickly, for the divided ends of the tendons of the extensors of the toes separate some little distance from one another, and their union will be weak, or the tendons will be lengthened too much, if extension of the foot be rapidly obtained. The instrument employed is one similar in construction to the shoe used in the treatment of congenital varus; the toe-wire is placed on the inner side of the sole-plate, so that the forepart of the foot may be drawn inwards, and a small pad is added at a point corresponding to the arch, in order to raise the inner surface. In the case of equino-valgus, section of the Achilles tendon is required after the distortion of the foot itself is overcome.

Non-congenital talipes valgus, the result of disordered muscular action, is much more commonly due to paralysis than to spasmodic contraction of the muscles. The condition of the foot present in a case of *paralytic valgus* is illustrated in Fig. 1490; the foot is everted, the inner border is placed on the ground, and the outer border forms a right angle with the outer surface of the leg. The limb exhibits that appearance of weakness which has been noticed as occurring in paralytic varus; the deformity results from paralysis of the tibialis anticus and posticus muscles; the peronei muscles, not being antagonized by their action, produce eversion of the foot on the leg.

Fig. 1490.



Paralytic valgus.

There is a condition of paralytic valgus which is not unfrequently combined with equinus, and which requires special notice; in cases in which there has been slight paralysis of the extensor muscles of the toes, or in which the attack has been more severe but in which the muscles have fairly recovered their contractile power, the shortening of the flexor muscles only occurs to an extent which prevents flexion of the foot to about a right angle on the leg; if with this slight paralysis of the extensors there is also present some loss of power of the tibialis anticus muscle, a tendency to eversion of the foot will also exist, and the deformity of equino-valgus will be developed. The early stage of this condition is generally allowed to pass on without treatment, because very little lameness is produced, and it is considered that what defect in this respect may exist, will disappear as the child grows older and stronger—an anticipation which is seldom realized. With the limited movement at the ankle-joint in the direction of flexion, which is caused by acquired contraction of the extensor muscles of the leg and foot, a considerable strain is thrown on the foot in walking, and as a consequence the mobility of the transverse tarsal joint becomes increased, and an unnatural amount of upward movement of the forepart of the foot on the os calcis and astragalus compensates the loss of flexion at the ankle. The tibialis anticus muscle being partially paralyzed, the inner border of the foot is not drawn up to the same degree as the outer border, so that the latter becomes raised and the former depressed; eventually the peronei muscles are secondarily contracted and a confirmed condition of valgus is established.

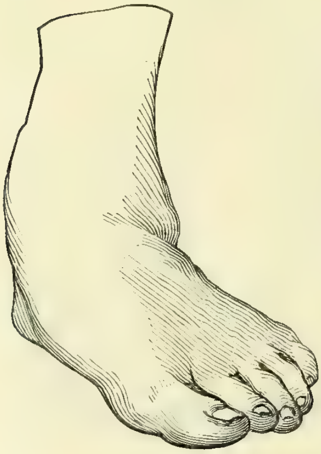
Talipes valgus resulting from *spasmodic muscular contraction* is always associated with equinus, and the condition of distortion is exactly similar to that developed in congenital equino-valgus (see Fig. 1489); the forepart of the foot and the heel are often greatly drawn up by the contracted muscles, and it is in cases of this nature that the most severe grade of valgus is met with.

In the *treatment of non-congenital valgus* resulting from muscular disturbance, tenotomy is always required; in the form arising from *spasmodic contraction*, the same course is followed in restoring the foot to shape as in the treatment of congenital valgus, the extensors of the toes and the peronei muscles being first subjected to tenotomy. For the mechanical treatment, a Scarpa's shoe with the divided sole-plate is used; a pad corresponding to the arch of the foot is placed on the inner side of the front plate, and the toe-wire is attached to the same side; the three cog-wheels, giving lateral movement, rotation, and uplifting of the front plate on the heel-piece, are also necessary. By the use of this instrument the forepart of the foot is brought down, the inner border is raised, and the outer border is depressed, the pressure of the pad on the scaphoid at the same time pushing that bone into its proper position; after the deformity in front of the transverse tarsal joint is reduced, the Achilles tendon is divided, and the heel is lowered as in the treatment of equinus. In *paralytic valgus*, mechanical treatment alone should be used if the deformity is not very severe, or of long standing; should muscular contraction have become confirmed, tenotomy must be resorted to, and in most cases section of the peronei tendons will suffice. That variety of paralytic valgus which results from contraction of the Achilles tendon with paralysis of the tibialis anticus muscle, is best relieved by first restoring the shape of the foot by mechanical treatment, and afterwards dividing the contracted tendo Achillis. In discussing the treatment of paralytic equinus, it was remarked that, in young children, tenotomy should not be employed when the heel was only slightly raised, except under certain circumstances; this qualifying statement referred to the coexistence of paralysis of the tibialis anticus muscle. When, therefore, this combination is present, it is always desirable to relieve the limited movement of the ankle-joint if it is found that the transverse tarsal joint is acquiring an abnormal amount of mobility, since otherwise the case is sure to become complicated by the development of valgus.

After restoration of the limb, a steel support fixed to the boot must be used, to assist the weakened muscles in the paralytic, and to counteract the action of the stronger muscles in the spasmodic variety; a steel bar on the outer side of the leg, with a T-strap attached to the inner side of the boot and buckling around the bar, is sufficient in slight cases, but, as with talipes varus, further support must be given by an inside bar, or by carrying the instrument to the thigh, when the distortion has been of a more severe grade.

Flat-Foot.—That form of valgus which is always non-congenital is commonly known as flat-foot; it results from a defective condition of the ligaments of the sole of the foot, and is invariably associated with debility. This affection is frequently met with in rachitic children, and in those who without any special indication of rachitis are nevertheless badly developed, with flabby muscles, and with a tendency to the formation of tissue which is excessive in bulk but deficient in quality. In such cases, the arch of the foot gives way from inability of the ligaments to support the weight of the body; in the rachitic child, the want of tenacity of the ligamentous tissues which is always present, is the direct cause of the deformity; in the heavy, ill-developed child, the fibrous tissue is not perhaps in such a defective condition as in the rickety infant, but the weight of the body is greater than the feet can support. At a later period of life, boys and girls of from ten to fifteen years of age often acquire flat-foot, especially those of the poorer class, who are badly fed and are obliged to work before they are sufficiently matured to bear the fatigue to which they are subjected. These cases are usually neglected until the arch of the foot is completely depressed, and relief is not sought for until walking causes so much pain that the subject is no longer able to follow his occupation. Pain is generally first felt on the dorsum of the foot, but in some cases the sole of the foot first becomes painful; the pain on the dorsum is due to the upper surfaces of the cuboid bone and os calcis, and of the scaphoid and astragalus, being pressed together; that which occurs in the sole of the foot arises from stretching of the calcaneo-scaphoid ligament, and from the pressure which is brought to bear upon the sunken arch. The occurrence of pain is followed by contraction of the peronei muscles and of the extensors of the toes, and this contraction is at first due to reflex irritation; as the deformity increases the muscular shortening becomes permanent, and pain along the affected muscles is added to that already existing. When this condition is reached, the foot presents the appearance illustrated in Fig. 1491.

Fig. 1491.



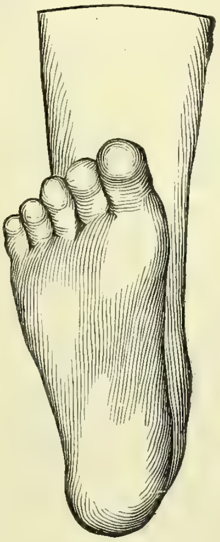
Flat-foot.

The *treatment of flat-foot* in the rickety or debilitated infant may always be successfully conducted by the use of mechanical means alone: a shoe similar to that employed in congenital valgus is required to restore the arch of the foot; after this has been effected, a pad must be worn in the boot to support the weakened foot when the child is standing or walking, and if the case was originally of a severe grade, the use of the instrument must be continued at night. If the deformity has been neglected, the peronei and extensor muscles may require division, in children three or four years of age.

In the early stage of flat-foot, arising in boys and girls who are suffering from debility and who are overworked, the exciting cause must be removed if possible, and a less fatiguing occupation be substituted for that which has produced the deformity; if placed in circumstances favorable for recovery, the arch of the foot soon becomes restored; pads should be worn in the boots, and the feet should be douched daily with cold water and shampooed on their under surface. If the deformity has progressed to such an extent that the arch is much depressed, mechanical treatment with the Scarpa's shoe, of the pattern used in the treatment of advanced congenital valgus, will be necessary for a few weeks; and when again permitted to use the foot, it is advisable that the patient should wear a steel support on the outside of the leg, extending from the calf to the boot. An excellent method of placing the feet in good position, in the early stage of flat-foot, is one suggested by Dr. Little: the patient sits in the position of a tailor, with the legs crossed and the feet resting on their dorsal surfaces, and by so doing inverts each foot and elevates the outer border; by adopting this position for several hours during the day, cases in the early stage may be cured without the use of Scarpa's shoe or other mechanical appliances. When pain has become developed, there will nearly always be found considerable contraction of the peronei muscles and extensors of the toes, with inability to invert the foot; but it must not be hastily decided that tenotomy is necessary under these circumstances, because, as has already been observed, the contraction of the muscles may be merely reflex, and may disappear when the foot has been rested and the pain has subsided. A few days' rest, with the foot placed in a Scarpa's shoe, should always be first tried, to ascertain if the contraction of the muscles is due to temporary spasm; if, after this, the shortening still continues, tenotomy must be employed. In the severe grade of distortion illustrated in Fig. 1491, the muscular shortening has become confirmed, and no doubt as to the necessity for tenotomy can exist; but even here a day or so of rest is advisable, because the muscles are in a state of excited spasm, and after tenotomy the divided ends of the tendons would separate to a considerable extent, more so perhaps than was desirable. After tenotomy, the foot is gradually restored to shape by use of the Scarpa's shoe in the manner already described; the patient must afterwards be provided with a walking instrument of the ordinary valgus pattern.

Talipes Calcaneus.—Talipes calcaneus is the least common of the four varieties of club-foot; it occurs as a congenital and as a non-congenital deformity. The *congenital form of calcaneus* is chiefly remarkable for the simple nature of the affection, which is limited to abnormal flexion of the foot upon the leg, without the occurrence of any distortion of the foot itself. In newly born children, the movement of flexion at the ankle-joint is obtainable to a much greater extent than at any other period of life, so that if spasmodic contraction of the flexor muscles is excited in the fœtus, the foot readily becomes drawn into an extreme state of flexion. This condition is illustrated in Fig. 1492, the case being that of a baby three weeks old, who was born with calcaneus of the right and equino-varus of the left foot; the shape of the foot is perfectly normal, but the dorsum is almost in contact with the anterior surface of the leg, and the heel is much depressed. This is an example of a severe grade of the deformity, and it has been selected to show what an amount of displacement of the foot upon the leg may occur without the foot itself being distorted; from this condition, calcaneus may vary in degree to one of merely slight interference with the movement of extension of the foot upon the leg. The pathological anatomy of this distortion presents no features worthy of special notice: the bones of the tarsus and metatarsus are in proper relationship one with another; the os calcis is obliquely situated, with its posterior surface directed downwards; the astragalus is drawn backwards under the tibia; the anterior ligament of the ankle-joint is slightly contracted, and the posterior ligament is somewhat stretched and weakened.

Fig. 1492.

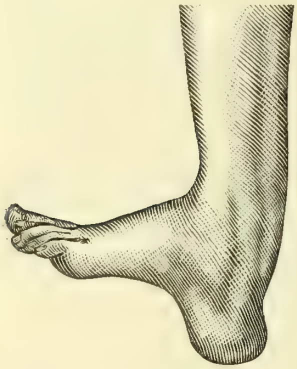


Congenital calcaneus.

Tenotomy is not often required in the *treatment of congenital calcaneus*, except in severe cases such as that illustrated in Fig. 1492, where the tendons of the extensors of the toes must be divided. When the anterior muscles are not much contracted, the deformity yields readily to manipulation and instrumental treatment; the foot may be exercised by drawing it gently down as far as possible into the condition of extension, then flexing and again extending it; the posterior muscles should also be well rubbed and shampooed to excite their contractible power. For the instrumental treatment, any form of appliance that will keep the foot extended on the leg may be used; the splint employed in the treatment of the second stage of congenital varus answers very well, the foot being extended by means of the cog-wheel which connects the foot-plate with the leg-piece.

Non-congenital calcaneus is usually the result of *paralysis* of the extensor muscles of the foot, and is of a much more serious nature than the congenital deformity, for it combines distortion of the foot itself with altered relationship of the foot and the leg. The character of this affection is shown in Fig. 1493; the heel is depressed, and appears to be much lengthened, owing to the formation of a cushion of hardened skin and thickened cellular tissue on its under surface; the arch of the foot is deepened; and the heel and the ball of the great toe are approximated. In this condition of deformity the os calcis is greatly changed in position, its long axis being almost vertical instead of horizontal, and its posterior surface pointing almost directly downwards; the astragalus is carried under the tibia, and its superior articular surface is directed backwards, the head of the bone being turned upwards. This is much the same condition of displacement that occurs in congenital calcaneus; in the paralytic form, however, the forepart of the foot does not retain its position on the posterior section, but becomes bent downwards, and thus causes the depression of the arch before mentioned. The cause of the foot itself becoming changed in shape in paralytic calcaneus, and not in the congenital variety, depends upon the different manner in which the two conditions are developed. In paralytic calcaneus all the muscles of the leg are found to be affected, the gastrocnemius and soleus being always extremely wasted, whilst the anterior muscles retain more of their contractile power; the heel thus first becomes depressed from the loss of action of the extensor muscles, and the forepart of the foot is then partially raised by contraction of the flexors, but not to an extent sufficient to correspond to the depression of the heel; the foot is thus bent upon itself at the transverse tarsal joint, being shortened, and its arch abnormally depressed. In congenital calcaneus the development of the deformity originates from excited contraction of the flexor muscles, which draws the foot up towards the leg, and at the same time depresses the heel; and from the mobility of the ankle-joint this depression can be carried to a degree which allows the whole foot to accommodate itself to the acting force without causing distortion at the tarsal joint. Non-congenital calcaneus, the result of *spasmodic contraction* of the flexor muscles acquired after birth, exactly resembles the condition present in the congenital variety; it does not attain to the same degree of severity, on account of the movement of flexion at the ankle being more limited at the age at which it is developed. A condition of deformity of the foot very similar to paralytic calcaneus, is not unfrequently met with as the result of mismanagement of paralytic equinus. If in a case of equinus of the nature illustrated in Fig. 1466, the tendo Achillis is divided before the contraction in the sole of the foot is relieved, and from want of care the tendon is lengthened too much, the heel becomes depressed, and the forepart of the foot is elevated as in the case of paralytic calcaneus;

Fig. 1493.



Paralytic calcaneus. (After Adams.)

the danger of thus substituting a new form of distortion for that previously existing has already been alluded to.[1]

Treatment of Non-congenital Calcaneus.—The reduction of the deformity existing in severe cases of *paralytic* calcaneus, such as that illustrated in Fig. 1493, can never be completely obtained, but a considerable amount of relief can be afforded by overcoming the contraction in the sole of the foot, and afterwards assisting the paralyzed extensor muscles by means of an appropriate support. The reduction of the distortion of the foot is conducted in precisely the same manner as in the treatment of advanced paralytic equinus; but in the state of calcaneus the surgeon has to contend with the difficulty arising from the posterior bones—the os calcis and astragalus—not presenting a fixed base to work upon, as they do when held by the contracted Achilles tendon in talipes equinus. After division of any contracted tissues that exist in the sole of the foot, a Scarpa's shoe of the pattern illustrated in Fig. 1468 is required for the mechanical treatment; the heel-piece of the shoe must be elevated as much as possible, so as to throw the os calcis and astragalus as nearly as may be in their proper places, and the front of the foot is then raised by means of the cog-wheel in the divided sole-plate. The manipulations previously described for stretching the shortened foot are of great assistance in overcoming this distortion; they may be employed about four weeks after section of the plantar tissues has been effected. When the foot has been so far restored to shape that the sole presents a good treading surface, an instrument must be used to which is attached a spring or elastic band designed to raise the heel in walking; a steel rod extending from the calf to the boot is jointed opposite the ankle, the joint being so constructed that the foot can only fall very slightly below the right angle; from the calf-plate a rubber band may be carried over and attached to the heel of the boot, or a spring may be placed on the side of the bar, which will elevate the heel and take the place of the paralyzed extensors. In the treatment of *spasmodic* calcaneus, tenotomy is required if the contraction of the flexor muscles has existed for some length of time, but as a rule the deformity yields very readily to instrumental measures.

HAMMER-TOE AND HALLUX VALGUS.

The conditions of distortion of the foot that have been described as constituting the various forms of club-foot, are capable of being classified into groups, and although no two individual cases of any one variety present precisely similar features, yet the description of a typical case of each of the different classes suffices to convey a clear idea as to the general character of the particular form of distortion. But there are numerous other deformities of the foot which differ so widely in their nature that it is impossible to assign them distinguishing titles; the foot may in fact be distorted in almost every conceivable manner. Some congenital distortions are due to arrested development: one or more toes, or a considerable portion of the foot, may be wanting; or the ankle-joint may be imperfectly constructed and the foot be in an abnormal position on the leg. The use of improperly fitting boots will give rise to various kinds of deformity; accidents, especially wounds, and burns or scalds, are a common source of distortion; and inflammation of the ankle and tarsal joints may also be productive of displacement of the foot. To this list of exciting causes numerous others might be added; in all the conditions thus induced, the methods of treatment employed in the reduction of the different forms of club-foot will generally be found of value, and a knowledge of those methods will be of great assistance to the surgeon in selecting the best means by which to relieve what may be described as the irregular forms of foot-distortion, which the limits of this article will not allow me to dwell upon in further detail. There are, however, two conditions of the foot not unfrequently met with which may receive separate notice; one of these, commonly called *hammer-toe*, is as a rule an acquired deformity, but may be congenital in its origin, while the other, which has been named *hallux valgus*, results from wearing badly constructed boots.

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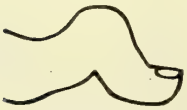
[1] See page 1015, *supra.*

Fig. 1494.



Hammer-toe.

Hammer-toe consists in the contraction of one or more toes into a claw-like position; it most commonly affects the second and third toes. The first phalanx of the contracted toe is drawn upwards on the metatarsal bone, the second phalanx is bent downwards so that the first phalangeal joint is much above the normal level, while the last phalanx is directed forwards, so that the toe presents the condition shown in Fig. 1494. This distortion is a source of much discomfort. A bad corn is always formed on the surface of the angular projection formed by the first phalangeal joint, and the last phalanx is generally very tender; trifling as the deformity appears to be, the subject will gladly submit to amputation of the toe if unable to obtain relief by other means. The *origin* of this distortion is somewhat obscure; like many other conditions of foot-distortion, it gives no trouble in its early stage, and is therefore at first neglected; it is more common among girls than among boys, and shows a preference for certain families; it is usually developed early in life, and is probably first started by contraction of the flexor muscles. As regards the *treatment* of hammer-toe, when the contraction has existed for any length of time, and has become confirmed, it is remarkably troublesome to overcome. The flexor[1] tendon must be divided, as must also the lateral ligaments of the first phalangeal joint; by this operation the toe can be straightened even up to adult age, but at a later period the joint surfaces are so changed that complete reduction of the distortion is impossible, although it may usually be sufficiently overcome to enable the subject to walk comfortably with a boot made large enough not to press on the front of the foot. After the operation, the toe must be stretched as quickly as possible by means of splints; if two or more toes are affected, a slipper, consisting of a padded metal plate and heel-piece, with slots cut between the toes, so that they can be tied down to the plate, is the most convenient appliance for use in the mechanical treatment.

Hallux Valgus is that condition commonly known as bunion of the great toe; it is caused by wearing tight boots, which are too short and too narrow to allow the foot to expand properly in walking. The whole foot is subjected to pressure, both from side to side and from before backwards, and the toes and metatarsal bones, which are the most flexible parts of the foot, become chiefly affected. The great toe is pushed into an oblique position, its ungual extremity being directed outwards and its metatarsal end pushed backwards and inwards, while the metatarso-phalangeal joint bulges out on the inner border of the foot, and a bunion forms over the surface of the joint; the extensor tendon slips away towards the middle line of the foot, and tends to still further drag the toe out of place. The second and third toes are usually squeezed above the great toe, but in some cases the latter lies upon the dorsal surfaces of the adjoining toes, which are then pressed downwards; the little toe is directed inwards, and the tarsal extremity of its metatarsal bone is often unduly prominent, with another bunion on its surface. This condition of deformity is thus one of mechanical origin; it occurs more commonly in women than in men, owing to the former being more addicted to the habit of compressing their feet with tight boots. The bunion over the metatarso-phalangeal joint of the great toe is liable to become inflamed and ulcerated, and the joint itself, from the pressure against its surfaces, is an additional source of pain which renders walking impossible and completely cripples the patient. The *treatment* of this deformity in the early stage consists in correcting the shape of the boots, and in drawing the great toe into place by means of a splint fixed along the inner border of the foot and carried to the end of the toe. When the distortion is more severe, the tendon of the extensor proprius pollicis muscle requires division; a slipper similar to that used in the treatment of hammer-toe, but with a spring attached to its inner border to invert the great toe, is required; a broad strap should also be passed over the phalangeal extremities of the metatarsal bones, so as to keep the forepart of the foot well spread out on the sole-plate, and the toe must be tied down and kept separated by means of tapes passed through slots cut in the same. After the shape of the foot is restored, the bunion must be protected by a shield of felt, and if thus protected from pressure it soon disappears.

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[1] It is somewhat singular that some authorities state that the extensor tendon requires division; this is from the nature of the deformity an evident mistake.

Curvature of Bones.

Curvature of the bones is generally due to rickets, and owing to the prevalence of this disease the deformity is very commonly met with amongst the poor of the large towns in England. Rickets is a general and not a local disease, of which curvature of the bones is only one of the symptoms, and not an essential characteristic; moreover, the deformity occurs in the later stages of the disease, and is not present until the affection is somewhat advanced in severity. Rickets affects infants who have been either improperly or insufficiently fed, and who are exposed to cold and damp, to which causes the development of the disease is generally ascribed by English physicians. It is a common practice amongst the lower classes for women to continue to suckle their children until they are fifteen or eighteen months old; such prolonged lactation is most injurious to the infant. Again, children who are brought up by hand are fed with milk which is largely diluted with water, and are thus deprived of sufficient nutriment; or sickly infants are given, with the view of strengthening them, various foods—such as arrowroot, gruel, potatoes, and meat—which their digestive organs are unable to assimilate. One or other of these errors will in nearly all cases of rickets be found to have been committed during infancy; prolonged suckling has been in my experience the most common cause of the disease, and next to this the administration of different kinds of starchy food. An infant thus circumstanced soon shows symptoms of defective health: sickness and diarrhœa, with swelling of the abdomen, are the first to appear; restlessness at night, sweating of the head, and general tenderness of the body quickly follow; next the epiphyses of the long bones become enlarged, those first affected being the ribs, at their sternal extremities, and the bones of the forearm and leg. There is a general condition of laxity of all the tissues: the skin is pasty, the muscles are flabby, and the ligaments are soft and wanting in tenacity; enlargement of the spleen, liver, and lymphatic glands may also occur, whilst there is a liability to the onset of various convulsive affections, of which laryngismus stridulus is said to be peculiar to this affection. The bones of the cranium develop slowly, and the fontanelles are late in closing; the skull is prominent at the sides; and the forehead bulges over the face, which is small and shrunken. The thorax is often flattened from side to side in its upper two-thirds, the sternum projecting anteriorly, whilst the lower ribs are expanded; the abdomen is much enlarged, especially below, and the lumbar spine is curved forwards. It is difficult to define exactly the defective conditions which constitute rickets; all the above are general symptoms which, with the exception of the enlargement of the extremities of the long bones, may or may not accompany the disease; in regard to the structural changes also, in the different tissues, there is no marked characteristic to be pointed out, except that present in the extremities of the long bones; there the proliferating cartilage is increased in breadth, and the cells are irregularly distributed instead of being placed in columns.

The period at which rickets is developed is usually between the ages of six and eighteen months, though it may commence at either an earlier or a later period; some authorities state that it exists as a congenital affection, but this assertion requires further investigation; curvature of the bones of the leg undoubtedly occurs before birth, but it does not necessarily follow that such curvature depends upon congenital rickets. The above description of rickets is merely introductory to the subject with which this article is directly concerned—curvature of the bones; there are many further points of interest connected with the disease, which have been fully considered in a previous volume.[1]

Rachitic curvature of the bones most commonly affects the *tibia* and *fibula*, and commences at the period at which the child first begins to walk; it arises from the bone-tissue being deficient in earthy matter, which renders it soft and liable to bend. The difference in the proportion of the organic and inorganic constituents of rachitic bone from that which occurs in the healthy state, has been variously given; no doubt it depends upon the condition of disease, the deficiency of the earthy parts fluctuating in amount according to the severity of the affection. The tibia and fibula are usually bent outwards, the most prominent part of the curves being a little below the junction of the middle and lower thirds of the bones; as the deformity increases, a forward curve of each bone is added to that already existing. The outward curvature of the leg gives the ungainly appearance commonly known as *bow-leg*, whilst the anterior curve causes the heel to appear abnormally prominent; combined with this distortion there is nearly always present rachitic valgus of the foot. The femur also is not unfrequently bent, the curve being formed in the upper two thirds of the bone, in a direction forwards and outwards. The gait of a child thus affected is very awkward: in order to get as wide a base of support as possible, the legs are straddled apart; to accommodate for the forward curve of the bones, the pelvis is somewhat tilted; and to compensate again for this, the upper part of the body is thrown backwards, and a condition of lordosis may become established in the lumbar region of the spine. A rickety infant not sufficiently strong to walk, but able to crawl about on his hands and knees, will develop curvature of the bones of the upper extremity; those of the forearm are chiefly affected, the curves of the bones being directed outwards.

In the *treatment* of rickets the point of first importance is to combat the dyscrasia: a suitable diet must be ordered, and the healthy action of the digestive organs restored; warm clothing and pure air must also be obtained for the infant if possible; as medicinal agents, cod-liver oil and steel wine are of great value. Whilst the bones are still soft, any curvature that may exist is easily remedied; if only slight in degree, and of recent origin, curvature of the tibia and fibula is best treated by stimulating the affected limb with the cold douche and shampooing, and by employing gentle manipulation to bend the curved bones into shape. The latter process is a very simple one: supposing that the right leg is under treatment, it is firmly held by the left hand, with the ball of the thumb resting against the outer side of the leg just above the curve; the lower part of the leg is grasped around the malleoli with the right hand, and the bones are gently straightened, then relaxed, and again pressed outwards, and so on for about ten minutes, the exercise being repeated twice daily. In a more advanced state of deformity, mechanical treatment is required; for this purpose a light wooden splint, which is sufficiently long to reach from the inner condyle to the sole of the foot, must be bandaged to the inner side of the limb; the splint should be slightly concave from side to side, and covered on its inner surface with padding, so that it may fit evenly and comfortably to the leg; it does not in any way interfere with walking, and if firmly and carefully applied, the curvature soon yields to the pressure exercised by the bandage. When rachitic curvature of the bones is allowed to remain unrelieved until the child is advancing in years, and has thrown off the disease, the deformity is much more difficult to overcome, because on the concave side of the affected bone the compact tissue is thickened to an abnormal extent, forming as it were a buttress to support the weakened side of the limb; this over-development of compact tissue may be carried to such an extent, in the tibia, as almost to fill up its concavity, and make the inner surface of the bone nearly straight. This consolidation of the curved bone is seldom present before the subject is from four and a half to five years of age; even in this advanced stage, the deformity may be remedied by the long-continued employment of mechanical pressure, but a more ready means of relief is obtained by resorting to the operation of osteotomy.

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[1] See Vol. I., page 251, *supra*.

Osteotomy, as its name implies, consists in cutting through a bone, by which procedure the surgeon endeavors to convert the case of deformity into one of fractured limb, which may be re-united in a straight position. As at present conducted, osteotomy may be regarded as a recently introduced operation; for although division of the long bones was performed many years ago, it is now attempted to bring the section of a bone into the same class of operations as the section of a tendon, and to include it within the range of subcutaneous surgery. Two methods of performing osteotomy are practised: the bone may be divided with a chisel (or osteotome) and mallet, or it may be cut through with a small saw.

Operation with Chisel or Osteotome.—In 1868, Mr. Stromeyer Little performed osteotomy by means of a chisel, making only a small puncture in the superficial tissues,[1] this being the first operation for which the subcutaneous principle was claimed; the case was one of bony anchylosis of the knee-joint. The bones were separated with a small chisel, one-quarter of an inch in width, and the puncture was afterwards closed with a pad of lint fixed with a bandage, just as the wound in tenotomy is treated; the case progressed without any symptoms of inflammation, and terminated most successfully.[2] Since this operation was done, considerable advance has been made in the method of conducting osteotomy; amongst others who have contributed to this result, Dr. Macewen has been particularly successful in his efforts to render the operation one that is safe and easily performed, and has introduced an instrument—the *osteotome*—which is much better designed for cutting through the bone than the ordinary chisel previously used. The osteotome is made of the finest steel, and is very carefully tempered; only the part near the cutting edge is raised to a great degree of hardness, the remainder of the blade being kept soft, so that there shall be no danger of its snapping; it is wedge-shaped and made of one piece of steel, the end forming the handle being octagonal in form, so that it may be grasped firmly, and the top being furnished with a rounded, projecting head; the side of the blade is marked with a half-inch scale, in order that the depth of the cutting edge below the surface may be recognized when the instrument is in use.

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[1] On In-Knee Deviation, by W. J. Little and E. Muirhead Little, p. 149. London, 1882.

[2] The same surgeon, in 1865, operated on a boy in the National Orthopædic Hospital who had curvature of both tibiæ; casts of the limbs before and after treatment are deposited in the hospital, and show an excellent result from the operation; for this case, however, the subcutaneous principle was, I believe, not claimed.

In performing osteotomy on the bones of the leg, the limb is steadied on a firm cushion, one filled with sand being the most convenient, and a small longitudinal wound is made with a scalpel down to the tibia, at the point where the section is to be performed; the osteotome is introduced through the wound, and its cutting edge is placed transversely across the bone, into which it is then driven by means of a boxwood mallet. When the section has been carried far enough to enable the operator to fracture the bone, the division is completed in that manner; the fibula is next divided, if that bone is so much curved as to prevent the limb from being placed in good position; some slight bleeding will occur from the bones, but no hemorrhage of any importance is to be anticipated. It is customary to adopt strict antiseptic precautions, but I have usually contented myself with taking care that the instruments used were perfectly clean, and in seeing that the patient was exposed to no septic influence during the operation; as soon as this is completed, the wound is sealed with a pad of lint and evenly covered with a bandage. In order to keep the limb in good position, three light wooden splints, nicely padded, must be provided; one of these is placed on the inner side of the leg, and should be sufficiently long to reach from above the knee to the sole of the foot; a second is placed on the back of the leg, and the third along the outer side, the two latter extending only from the upper part of the leg to the ends of the malleoli. The first splint should be fixed so that it may remain unmoved, whilst the others may be adjusted as often as necessary during the treatment; by means of small pads, placed between the limb and the back and outer splints, the pressure at any spot may be relieved or increased as is found requisite. The after-management of the case is conducted just as is the treatment of a compound fracture of the leg, so that no remarks are called for on this subject; the superficial wounds heal up readily, often by adhesion, and the case usually progresses, to use a familiar expression, without a bad symptom.

Operation with Saw.—In the second method of dividing bone, which is now very frequently practised, the instrument used is a small saw with a double cutting edge, set at the end of a slender shank to which a pistol-shaped wooden handle is attached; this saw was used in 1869 by Mr. Adams, when performing for the first time his now well-known operation of subcutaneous division of the neck of the thigh-bone. With the saw, section of curved rachitic bones can very readily be accomplished; a small knife, shaped like a tenotome, and sufficiently large to make a wound which will admit the saw, is first passed down to the bone at the point where the section is to be performed; down this track the saw is pushed until it reaches the bone, through which it can be made to cut its way very easily.

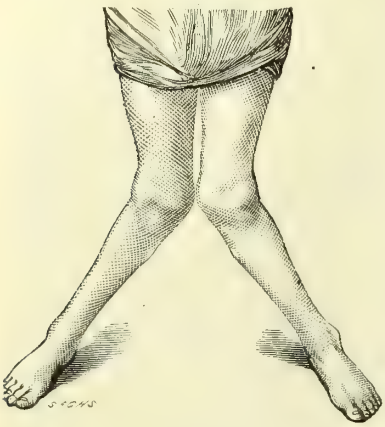
These two methods of performing osteotomy, with the chisel and with the saw, have superseded all other plans previously adopted. Some difference of opinion exists as to which is the better method; in my judgment each has its respective merits. Much depends upon the situation of the bone and its anatomical relationship; when near the surface and with no adjacent structures which are likely to be injured, the chisel is perhaps to be preferred to the saw; but when the bone is more deeply situated and has to be reached through a layer of muscles, and care has to be taken to keep the cutting instrument within a well-defined course, the saw is a much safer tool to employ, because it is more completely under the command of the operator; moreover, the saw is so light and handy that it conveys more information to the sense of touch than does the heavier and more clumsy osteotome. Whether these operations are entitled to be described as strictly subcutaneous, is an open question; in dividing the tibia, for instance, with the osteotome and mallet, more can hardly be claimed than that the external wound is a very small one, and much less in extent than the deeper section which is made in the bone, for there is not here sufficient superficial tissue to act as a packing to the chisel, and tô prevent the entrance of air to the deeper tissues, the general appreciation of the risk of which occurrence is shown by the fact that most authorities advise that so-called antiseptic precautions should be adopted when operating. When, however, the bone is more deeply situated, and the small saw is used and passed through a track only just large enough to admit it, the surrounding tissues closely embrace it and prevent any air from entering, thus rendering the operation a strictly subcutaneous one. In the above description of the various methods of treatment, reference has been made chiefly to rachitic curvature of the bones of the leg, and it is not necessary to further enlarge upon the general subject by giving the details of treatment necessary in curvature of the other long bones of the extremities, for the same general principles are applicable in all cases. One point is, however, deserving of notice with regard to the development of this affection, viz., as to how far rickets and curvature of the bones may occur independently one of the other. That the former frequently exists without the latter, is very certain, whilst it not unfrequently happens that children have acquired curvature of the bones of the leg who present no indications of the rachitic taint. I believe that the bones may be bent by the mere pressure exercised by the weight of the body, just as the arch of the foot may be broken down to a condition of valgus, and that this condition of curvature may be developed at any period of life between infancy and the completion of growth.

GENU VALGUM.

Genu valgum, or *knock-knee*, is, like curvature of the bones, usually associated with rickets; it is therefore commonly met with amongst the poorer classes in England, and the two deformities are frequently developed in the same individual. Rickets is not the only source of genu valgum: it may also result from debility, from mechanical causes, and from muscular contraction; but as the deformity presents much the same external appearances in all conditions, the rachitic type may be selected for descriptive purposes.

The nature of distortion present in a severe case of *rachitic genu valgum*, is illustrated in Fig. 1495, the subject being a boy aged sixteen years. The most noticeable feature of the deformity is the altered relationship of the leg with the thigh, from which the affection derives its title; instead of holding its normal position, the leg is deflected outwards, so that in a case of double deformity, such as that here illustrated, the ankles are widely separated from one another. This eversion of the legs is not so evident when the subject stands in the position ordinarily assumed by those affected with knock-knee, for the thighs are carried obliquely inwards so as to bring the feet more under the centre of gravity of the body, a practice which, in cases of long existence, induces an abnormal increase in the adduction of the femur at the hip-joint. Accompanying the displacement of the leg, the structures surrounding the knee-joint are also involved; thus, on the outer side of the joint the external lateral ligament is shortened and contracted owing to the approximation of its points of attachment, and the tendon of the biceps muscle and the deep fascia are similarly affected; on the inner side, the lateral ligament is stretched and weakened. When genu valgum has existed for some years, the joint-surfaces become changed in shape, the plane of the condyles from side to side being abnormally oblique from above downwards and inwards, whilst that of the tibia slopes upwards and outwards.

Fig. 1495.



Genu valgum.

Knock-knee, the result of rickets, is directly caused by the lax condition of the ligaments which is so frequently associated with that disease. Any one who has frequent opportunities of examining rickety children, may satisfy himself on this point by testing the limbs of those who are markedly affected with the dyscrasia; it will be found in such cases that a very decided amount of lateral movement of the knee-joint can be produced when the leg is fully extended on the thigh, an amount of abnormal mobility which arises from the lateral ligaments being too weak to keep the joint-surfaces firmly braced together. A joint thus loosely knit soon gives way under the weight of the body, and, as the internal lateral ligament is from its construction the least able to resist pressure, the displacement occurs in an inward direction; the oblique position of the femur perhaps also contributes to determine the development of a valgoid knee. When the deformity has been thus started, it usually progresses somewhat rapidly, and in a few months a severe condition of distortion may be established; on the other hand, a more healthy condition of the ligaments may arise, and the displacement may become arrested before much mischief has been caused. The presence of genu valgum in no way interferes with the movements of flexion and extension of the joint, and the subjects of this deformity, even when it exists in a severe grade, possess very good powers of walking; when the leg is flexed to a right angle on the thigh, the distortion disappears, because in this position the contracted structures on the outer side of the joint are relaxed. As has been before remarked, rachitic genu valgum is very often accompanied by curvature of the bones of the lower extremity; there is also always present some enlargement of the bones which enter into the formation of the joint; the inner condyle is apt to be especially prominent, and so is the inner surface of the head of the tibia, the projection of these parts of the bones forming a very marked swelling on the inner side of the joint; exostotic masses of bone are also not unfrequently formed on the inner surface of the shaft of the tibia, a short distance below its head.

Genu valgum the result of debility, is, as far as the external characteristics of the deformity are concerned, very similar to the rachitic variety; it does not, however, attain to such a degree of severity. The subjects of this affection are young children who are overloaded with fat and possessed of somewhat lax tissues, in whom, as has already been noted, talipes valgus is also frequently developed; again, those who have suffered from exhaustive diseases which have left a permanent condition of weakened health are liable to acquire the deformity. At a later period of life, youths of both sexes, who are employed in occupations which compel them to stand or walk during the greater part of the day, very commonly become knock-kneed, from sheer inability of their joints to withstand the strain to which they are subjected. Many of these cases should rather be classed as of *mechanical origin*, for although a defective state of health is generally produced by such a mode of life, yet it is not uncommon to meet with youths who have acquired genu valgum and yet remain in other respects robust and strong. The development of knock-knee from *muscular contraction* is usually associated with some other deformity of the joint arising from the same cause, and can be more conveniently considered in another part of this article.

Treatment of Genu Valgum.—Genu valgum may be regarded as the simplest of all the deformities of the body which are presented to us for treatment; the distortion does, however, in a few cases assume an intractable character, owing to advanced changes within the joint; these exceptional instances require separate notice, and it will be convenient before discussing them to proceed with the consideration of the treatment of the usual conditions of distortion such as have been described above. Knock-knee is peculiarly amenable to treatment for two reasons: first, the defect in the condition of the joint is remarkable for the simplicity of its nature, and we have not here, as in the case of distortion of the foot, to deal with the serious derangement of a complex piece of mechanism, the separate parts of which require to be restored to place in order to reduce the deformity; secondly, the position of the joint is very favorable for the application of remedial measures, since the thigh and leg form long levers which can readily be utilized for the employment of well-regulated mechanical pressure.

In the early stage of knock-knee, treatment must be directed to restoring the ligaments to a healthy condition, and to preventing those structures from becoming stretched before they have acquired their normal tenacity. Attention to the general health is the matter of first importance, whilst for local treatment the joint should be douched daily with cold water, and afterwards well rubbed and shampooed, especially on its inner surface. If the child is able to walk fairly well, he should be encouraged to use his limbs, and not, as is frequently advised, be kept entirely at rest; if necessary, a light knee-cap, stiffened with steel springs, may be worn to support the weakened joint as long as a tendency to deformity continues to exist. If displacement of the leg is more advanced—to such a degree, for instance, that the ankles are separated three inches from one another when the limbs are extended and placed together—mechanical treatment may be added to the above, by applying splints to the legs during the night, and for a few hours during the day. The splints should be shaped and padded like those already described for the treatment of curvature of the leg-bones, and must be sufficiently long to reach from an inch above the great trochanter to the sole of the foot; they are placed on the outside of the limb, and are firmly fixed with a bandage. In a still more severe grade of deformity the straight splint is not a convenient appliance to use, because it is liable to slip around to the front of the leg and thus lose its purchase; it is for such cases advisable to divide the splint opposite the knee-joint, and to connect the thigh and leg pieces with a cog-wheel which gives lateral movement; a broad knee-cap, extending well above and below the knee, may also be attached to the splint, and will be found of great assistance in keeping the limb in place.

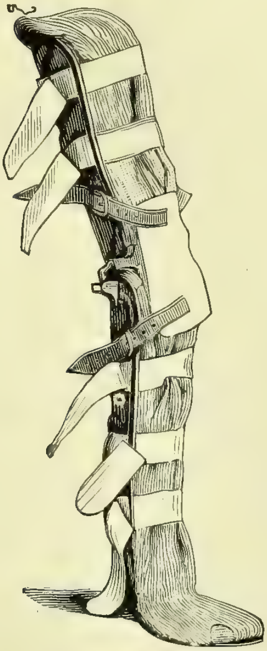
In these more advanced cases of the deformity, the structural shortening of the external lateral ligament is the chief obstacle to be overcome in straightening the leg; in order to hasten the reduction of the deformity it has been recommended that this ligament should be divided subcutaneously. There is no objection of any importance to be advanced against this operation, but in my opinion a more advisable plan is to stretch the ligament gradually by *daily manipulation of the knee*, a process which is practically as rapid as the more heroic measure of dividing the ligament and puncturing the synovial membrane of the joint. It must be remembered that the relief of knock-knee, to be complete, must include the restoration to its normal condition of the weak internal lateral ligament, and that this result can only be obtained by time; so that, even if the contraction on the outer side of the knee be instantaneously removed, instrumental treatment must be continued until the weakened structures on the inner side have acquired strength, as otherwise the condition of valgus will be sure to return. In manipulating the knee for the purpose of stretching the external ligaments, the joint is held firmly on the inner side with one hand, while the leg is fully extended and grasped just above the ankle with the other hand, and steadily pressed inwards; as much force may be used as the patient can bear without feeling pain, and the limb may be "worked" in this manner for ten minutes or a quarter of an hour every morning and evening; the rubbing and shampooing of the inner side of the joint, as previously described, should be practised before the manipulation.

In the most severe grades of genu valgum, as has already been described, the plane of the articular surface of the femur is often abnormally oblique, owing to partial absorption of the surface of the outer condyle, and to elongation and thickening of the inner condyle. This change in the articular surface of the femur does not much increase the difficulty of reducing the deformity in the case of young children, for nature gradually reshapes the joint-surface as the bones are restored to their proper positions. When, however, knock-knee has been developed in early life and has been allowed to continue unrelieved until the subject is about twelve years of age, the elongation of the inner condyle may become a serious complication of the distortion; fortunately, such cases are of somewhat rare occurrence, and even the severest grade of distortion will yield to the employment of a method of treatment similar to that above described. In the mechanical treatment of these cases, the trough-splint (Fig. 1496) more completely controls the limb, and is a more convenient appliance to use, than the simple outside splint. It practically consists of the divided outside splint, with the addition of a foot-piece and of back splints for the thigh and leg; a knee-cap and straps for the purpose of fixing the limb are also added; this instrument requires some little caution in its use, for, from the length of leverage of the thigh and leg pieces, a great amount of force can be brought to bear upon the knee by turning the cog-wheel opposite the joint. The most severe conditions of deformity will yield to the trough-splint and manipulation; the case illustrated in Fig. 1495 was treated by this method, and at the end of three months the patient was able to stand and be photographed in the position shown in Fig. 1497.

Operative Treatment of Genu Valgum.—In cases of genu valgum which have existed for some length of time, and in which the inner condyle is considerably increased in length, the reduction of the deformity can be more readily achieved than by the above methods, by resorting to an operation on the lower extremity of the femur, for the purpose of rectifying the obliquity of the articular surface. Several different operations have been devised and practised with the object of remedying the hypertrophy of the inner condyle; those which are adopted in the present day differ in some important respects from one another.

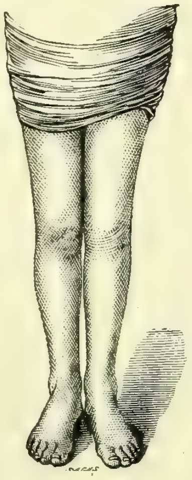
In May, 1876, Dr. Ogston first performed the operation which is associated with his name; in this method the skin is punctured above the inner condyle with a long, narrow knife, and a small oblique wound is made downwards in front of the condyle, through the synovial membrane, dividing the structures in front of the bone, the knife being kept just to the inner side of the crucial ligaments. Down the passage thus made a small subcutaneous saw (Adams's pattern) is passed, and the bone is sawn through from before backwards, thus separating the inner condyle; the leg is then straightened, the condyle being pushed up to its proper level, where it unites, and the obliquity of the articular surface is thus corrected.

Fig. 1496.



Trough-splint for genu valgum.

Fig. 1497.



Genu valgum after treatment. (From the same patient as Fig. 1495.)

In May, 1877, Macewen modified this operation by removing a wedge-shaped piece of bone from the side of the inner condyle, afterwards pressing together the cut edges of the bone; but in February, 1878, he adopted an entirely different plan, which avoids any interference with the cavity of the knee-joint. In this operation a wedge-shaped cut is made with an osteotome into the lower end of the femur, on its inner side, just above the level of the epiphysis; the exact spot for making the incision through which the osteotome is passed is found by drawing a transverse line, level with the upper border of the patella, and a second, longitudinal line, about half an inch in front of the attachment of the adductor magnus muscle; where these lines intersect is the point for the incision. The bone is cut through until it can be either broken or bent so as to allow the leg to be placed in a straight line with the thigh. The operation is performed antiseptically, and has been practised by Dr. Macewen in a large number of cases without the occurrence of any fatality due to the operation itself; in one or two cases suppuration occurred in the wound, the amount of pus varying from a few drachms to several ounces. Dr. Macewen, speaking of this and other operations on the bones which he has performed after the same method, says, "the wounds enable the instrument to reach the bone; but as they are generally made more or less obliquely, while the osteotome, after introduction, is turned transversely to the axis of the limb, there is an aperture on each side of the osteotome, leading from the external air directly to the interior of the bone." "They are therefore not subcutaneous osteotomies, but examples of compound fractures and incisions treated antiseptically."[1]

Mr. Reeves, in 1878, performed an operation which he describes as being extra-articular: an oblique cut is made with the chisel into the inner condyle, while the leg is flexed so as to draw down the synovial membrane; the condyle is not completely separated, the incision only extending to within one-eighth of an inch of the articular cartilage. The leg is forcibly straightened, and afterwards encased in a plaster-of-Paris bandage which is taken off on the tenth day after the operation, gentle passive motion being then continued daily until the full movement of the joint is restored.[2]

A fourth operation is that introduced by Mr. Barwell,[3] who regards the deformity "not as a mere lengthening of the inner condyle, but as an obliquity of the whole lower epiphysis of the femur," and also says that "in examining the tibia one finds the portion of bone for an inch below the knee-joint perfectly normal; just at that distance below the articulation one feels, in well-marked cases of knock-knee, an angle from which the shin bone slopes outward." To remedy this variety of genu valgum, Mr. Barwell performs osteotomy upon both the femur and the tibia.

Of these four operations, that practised by Dr. Macewen is in my opinion the safest method of procedure to adopt, when in the advanced stage of knock-knee the articular surface of the femur is abnormally oblique. Dr. Ogston's operation has more than once resulted in suppuration within the cavity of the joint, and in one reported case the patient died from septicæmia; again, there is a risk of raising the inner condyle too high, and of producing the opposite condition of deformity—*genu extrorsum*—two instances of which occurrence have come under my observation. In Dr. Macewen's operation the joint is not interfered with, and the danger of failing to correctly shape the articular surface is much less, because the separated portion of bone is larger and better under command than is the small and freely movable condyle. I have also met with a case of genu extrorsum caused by performing Mr. Reeves's operation; the unfortunate termination which attended these three cases could not have been due to any want of skill on the part of the operator, for in each case the surgeon was well experienced in the method of treatment which he was employing. The possibility of thus substituting one condition of deformity for another, by interfering with the joint-surface, is a fact of considerable importance; the condition of genu extrorsum which is thus caused is by no means easy to overcome, and probably the deformity can only be completely reduced by resorting to osteotomy of the outer condyle. A reference to the English medical journals of the last few years shows that much want of discrimination has existed in selecting appropriate cases of genu valgum for treatment by osteotomy. Numbers of young children have been operated on, who could quite as quickly, and much more safely, have been relieved of their deformity by the simple measures of treatment which have been above described.

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[1] Lancet, September 18, 1880.

[2] Transactions of the Clinical Society of London, vol. xii.

[3] British Medical Journal, October 18, 1879.

DEFORMITIES OF THE LOWER EXTREMITY FROM MUSCULAR CONTRACTION.

The numerous conditions of non-congenital deformity of the foot which result from nerve-lesion and muscular disturbance, are often accompanied by contraction of the leg and thigh, arising from the same exciting causes. In the case of paralytic talipes, the leg is not uncommonly flexed upon the thigh, owing to the extensor muscles having lost their contractile power, and having been overpowered by the action of the flexors; the biceps is especially powerful in producing this condition of flexion at the knee-joint, and in many cases this muscle also rotates the leg outwards, and everts it, thus inducing a condition of genu valgum. Flexion of the thigh upon the pelvis is caused by the unbalanced action of the psoas and iliacus muscles; the limb is also adducted by the contraction of the inner muscles, and the tensor vaginæ femoris and sartorius muscles are frequently shortened. This state of deformity may be present in both lower extremities, in which case the subject is either entirely deprived of all power of progression, or is only able to crawl about on his hands and knees. In the *treatment* of these cases the several conditions of deformity must be taken in separate stages: first, the deformity of the foot is reduced; next, the displacement of the leg upon the thigh; and finally, the contraction of the thigh on the pelvis. The modes of reducing the various conditions of paralytic deformity of the foot have already been described; the relief of the contraction of the leg is obtained by following similar principles of treatment. When the deformity is of recent origin, physiological and instrumental measures will usually suffice to restore the normal condition of the limb; galvanism, with rubbing and shampooing of the weakened parts, and manipulations to stretch the shortened muscles, constitute the physiological methods that may be employed; for the instrumental treatment, an appliance consisting of thigh and leg pieces connected by a cog-wheel at the knee-joint, and with straps for fastening the limb, is required, so that the leg may gradually be extended to its proper position.

In more severe cases of long standing, in which structural shortening of the flexor muscles has become established, *tenotomy* must be had recourse to as the only method of reducing the deformity; division of the hamstring tendons is easily accomplished, as they stand out very prominently, and are easily felt under the surface of the skin. The tendons of the semi-tendinosus and semi-membranosus muscles should be cut by passing a sharp-pointed tenotome under them, entering on their inner side, and dividing from below upwards, towards the surface; the biceps tendon is divided in a similar manner, but care must be taken not to include the external popliteal nerve in the section. Some contracted bands of fascia are often present on the side of the joint, in which case they also must be cut through. The wounds are treated just as those of tenotomy for club-foot, and the limb is kept quiet for a few days by bandaging it to a splint extending up the thigh and down the leg. Instrumental treatment may be commenced on the fourth or fifth day, extension of the leg being then carried on steadily until the full movement of the joint is restored. Contraction of the thigh upon the pelvis nearly always requires the employment of tenotomy, the muscles most affected being the tensor vaginæ femoris, the sartorius, the adductor longus, and the adductor magnus. No special directions are required for these little operations; the tendons of the two first-mentioned muscles may be divided just below the anterior superior spinous process, those of the adductors where they can most readily be felt at the inner and upper part of the thigh. The replacement of the thigh is not always accomplished very easily, even when tenotomy has been freely had recourse to; the difficulty arises from the pelvis not affording a good bearing upon which to apply an instrument; the best results can generally be obtained by the steady employment of weight-extension, which may be made to draw the thigh down upon the pelvis, and also to abduct it. Manipulations may be practised in the later stages of treatment, and appropriate exercises may be ordered to strengthen the weakened muscles; if the adduction is persistent, and does not yield readily, a good plan is to make the subject sit on a saddle, the width of which may gradually be increased as the contraction is overcome.

A condition of deformity very similar to the above, as far as the position of the limbs is concerned, results from spastic contraction of the flexors and adductors of the lower extremity; the treatment of this distortion necessitates the same course of tenotomy and instrumental means as in the case of paralytic contraction.

The effects of treatment in these cases are usually very satisfactory; even with extreme loss of power of the paralyzed parts, a useful limb can be obtained by overcoming the contraction and placing the weakened muscles in a condition favorable for exercising what amount of contractile power they may retain. When the patient is sufficiently recovered to be allowed to use his limbs, steel supports, extending from a band around the pelvis to the boot, are required; if the extensors of the leg be much wasted, the knee-joints must be fixed by a slip-catch, which will prevent the knees giving way when the child tries to stand. Crutches, or, what is still better, a go-cart, should be used in the first attempts to walk, and as muscular strength is regained, these artificial aids must gradually be removed and the child be encouraged to trust as much as possible to his own efforts. The progress towards recovery is slow, especially when the condition of deformity has existed for some years before being submitted to treatment; the spasmodic cases are the most tedious in their course, but even here much can always be done to improve the walking powers by steadily persevering with the instrumental treatment. A case that was under my care some years ago, in 1878, is a remarkable instance of the power of self-recovery which the muscles possess when restored to a condition which promotes their proper action:—

A young gentleman, aged 18, had suffered from infancy from spastic contraction of the flexors and adductors of the lower extremities; he had never walked, and his only mode of progression was by crawling on his hands and thighs. There were equino-varus of both feet, flexion of both legs, and flexion and adduction of both thighs; he was nevertheless well developed, and much above the ordinary height and weight. The various conditions of deformity were relieved one after the other, and instruments to support the limbs, with crutches, were used in his first endeavors to walk; gradually one crutch and then the second were discarded, and two sticks were substituted; he could, in 1883, walk three or four miles with the instruments and one stick only, and could even get about for short distances without any artificial assistance whatever.

DEFORMITIES OF THE UPPER EXTREMITY.

Contraction of the *hand*, *forearm*, or *arm*, may result from muscular disturbance, and may be present either as a congenital or as a non-congenital affection. The congenital deformities of the hand have been compared with those occurring in the foot; thus, when the hand is flexed and pronated, owing to shortening of the muscles which produce those movements, the distortion has been regarded as of a nature similar to talipes varus; again, when the extensors and supinators are contracted, a comparison has been drawn between the state of the hand and talipes valgus. Congenital contraction of the hand is seldom of a severe nature, although a slight degree of muscular disturbance is often met with; tenotomy is consequently very rarely necessary, and the use of a small flexible splint, similar to that employed in the treatment of slight varus, will soon overcome the contraction. Non-congenital affections of the upper extremity are usually due to muscular paralysis; these cases present no special interest, and scarcely admit of any classified description. Their treatment is conducted on the same plan that is employed in paralytic deformities of the lower extremity, and here again mechanical treatment usually suffices without tenotomy.

Dupuytren's Contraction of the Fingers.—This affection, which has been named after the eminent French surgeon who first explained its pathology, is characterized by flexion of the fingers upon the palm of the hand. Dupuytren, having obtained for dissection the hand of a subject of this contraction, proved that the muscles and tendons took no part in producing the deformity, for he found that the palmar fascia was shortened and contracted, and that after dissecting off this structure, the fingers could be perfectly straightened; nor did further examination discover any abnormality of the tendons or joints. This disease usually commences with slight hardening of the palmar fascia in the middle of the palm, below the ring and little fingers; the skin next becomes slightly adherent and dimpled, being somewhat thickened around the depression. The induration of the aponeurosis and skin progresses until a band of thickened fascia can be felt passing upwards towards the base of one of the fingers. This band increases both in width and depth, until it is clearly displayed beneath the skin when the finger is pressed backwards to its full degree of extension; the finger next becomes drawn forwards, and is held by the contracted band in a straight line with the metacarpal bones, and gradually the movement of extension becomes more and more limited until the finger is brought down to a condition of flexion. The contraction usually commences by bending of the first phalanx on the metacarpal bone, the second phalanx being afterwards

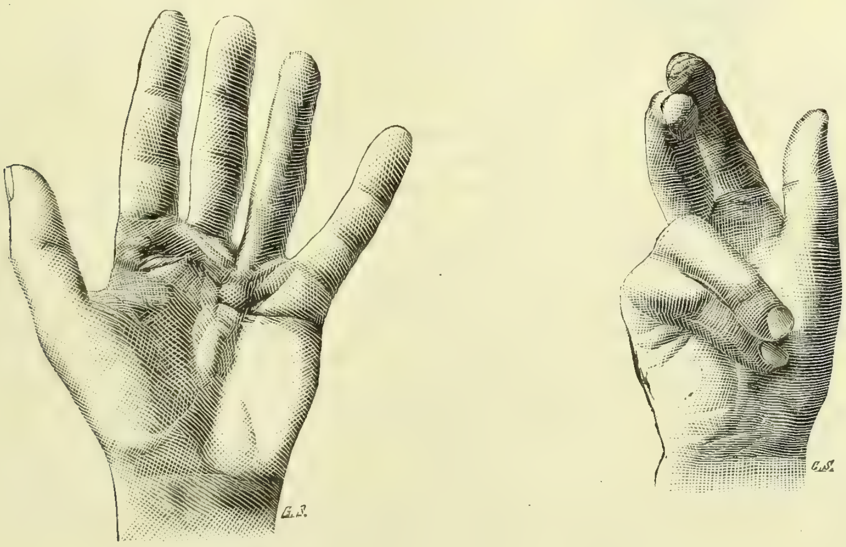
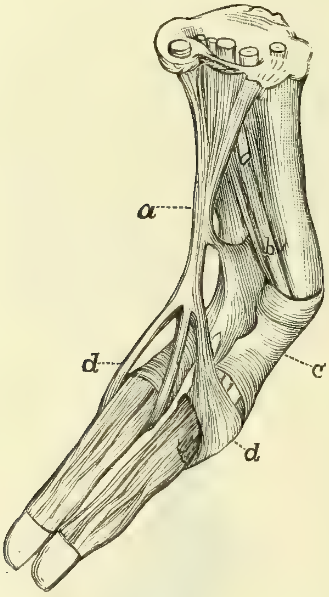


Fig. 1498. Fig. 1499.

Dupuytren's finger-contraction.

drawn down upon the first; generally, too, it affects one finger, either the ring or little finger, much more than the others; but much variation occurs in these respects. It is rare to find more than three fingers included in the deformity, but any one may be contracted, or all, including the thumb, may be implicated in one hand; the finger which most frequently escapes is the index finger. The condition of the hand in the early stage of the affection is shown in Fig. 1498; the broad band of fascia extending from the palm to the ring and middle fingers is clearly seen, as well as the commencing flexion of the first phalanges of the affected fingers upon the metacarpal bones. Fig. 1499 illustrates a more advanced state of the deformity, the fingers here being contracted also at the first phalangeal joint, and so much drawn downwards that the band in the palm of the hand is almost hidden from view. Fig. 1500, which is a drawing from a dissection in St. Bartholomew's Hospital, London, shows the contracted band of fascia in the palm (*a*), with prolongations extending to the joints of the first and second phalanges of the middle and ring fingers; the flexor tendons are seen at *b*, passing into the sheath *c*. This drawing very clearly illustrates the pathological anatomy of the affection, and proves how entirely the contraction of the fingers is dependent upon changes occurring in the palmar fascia, and that it is not in any way contributed to by shortening of the tendons.

Fig. 1500.



Dissection of Dupuytren's finger-contraction. (After Adams.)

Upon what *cause* the development of this contraction of the palmar fascia depends, has not yet been clearly made out; it has been described as an affection of purely local origin, arising from constant irritation of the palm of the hand in manual labor. Adams, who has most carefully studied the nature and treatment of the disease, controverts this theory and leans strongly to the opinion that it is of constitutional origin, regarding it as depending upon a gouty diathesis.[1] He says that, in the majority of cases, there is "a well-marked family history of gout, although the patients suffering from contraction of the fingers, in many instances, have not themselves suffered from gout in any form." Mr. Adams further remarks that he has seen "but very few cases of Dupuytren's contraction in the laboring class, and has failed to obtain evidence of its frequent occurrence amongst any particular class of mechanics; whilst the cases that did present themselves, generally occurred in butlers and indoor servants."[2] He further calls attention to its prevalence amongst the upper and middle classes of society, to the fact that it frequently occurs in the left hand only, and also to its not uncommonly being an hereditary affection. That this affection is almost always associated with gout is supported by my own experience; of the few cases that have been met with at the National Orthopædic Hospital, all exhibited well-marked symptoms, or a clear family history, of gout. In private practice, one patient only has failed to show any history of the constitutional disease, either personal or hereditary ; this gentleman had lived an active life for many years, and it was after his settling down to a more quiet and sedentary mode of life that the contraction of the hand became developed; probably therefore it was here due to gout, but was the sole indication of the disease, which may yet display itself in a more pronounced manner.

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[1] Observations on Contraction of the Fingers, etc., page 20. London, 1879.
[2] Op. cit., page 22.

Local irritation has, nevertheless, some influence in producing the palmar contraction, and in regard to this point two cases which have come under my observation are worthy of notice. In the first case, a gentleman who up to the age of about fifty years had been in the habit of riding and driving a great deal, was affected with slight thickening of the fascia, with dimpling of the skin on the palms of both hands, without however suffering from any symptoms of gout. Shortly after this slight contraction appeared, this gentleman so changed his practice as almost entirely to give up either riding or driving; the Dupuytren's disease became arrested, but soon afterwards other well-marked symptoms of gout were developed. In the second case, a gentleman whose occupation was purely of a professional character, and who was addicted to no further manual labor than is usually associated with the ordinary course of life, had, before retiring into private life, suffered from gout; living afterwards in the country, and devoting himself with some enthusiasm to gardening and such like out-door pursuits, he acquired well-marked contraction of the palmar fascia in both hands, the other gouty symptoms at the same time almost entirely disappearing. These cases, and others of a similar nature which might be quoted, prove distinctly that the influence of a local excitant must not be disregarded in investigating the origin of this disease; the fact that in the first case a discontinuance of using the reins[1] was followed by a cessation of the advance of the contraction of the fascia, and that in the second case the use of gardening implements was necessary to start the disease, shows that in the gouty subject local irritation will very probably act as the exciting cause of this affection; whilst the fact that it is nearly always accompanied by gout, indicates that the latter is its chief predisposing cause.

The time of life at which this contraction commences is usually between the ages of thirty and forty years, but it may begin at an earlier or later period. It is rarely met with in women; I have seen three such cases only, one of which has furnished Fig. 1499, the subject being a woman who was markedly affected with gout, and whose occupation was that of a charwoman; another of these three cases was in a woman in a humble station of life, who was in the habit of using her hands in somewhat rough work; whilst the third was in a lady, in whom, however, the disease did not assume a very aggravated form. A condition of finger-contraction which is very common to the female sex, and which is often mistaken for Dupuytren's contraction, may here be referred to. The deformity is nearly always congenital, or of a very early origin; it is usually met with in the little finger only, and affects the first phalangeal joint; there is no contraction of the fascia of the palm ever present, and the condition seems to be somewhat closely allied to hammer-toe.

Treatment.—Except in the very earliest stage of contraction, the relief of this affection can only be obtained by subcutaneous section of the fascia. So effectual is this method of treatment, and so superior is it to all other methods practised, that I feel justified in proceeding at once to a description of the mode of operation, and of the necessary mechanical treatment to be afterwards adopted. The procedures here given are those established by Mr. Wm. Adams, of which a detailed account will be found in the work already referred to; from my own personal experience of this method of treatment, and from having fortunately been able to watch the practice of Mr. Adams himself in the management of a large number of cases, I can assert that all conditions of this affection, of whatever severity they may be, are capable of relief. To obtain success, however, some knowledge of the use of mechanical appliances, and an aptitude in the performance of the subcutaneous section of contracted tissues, are necessary; for there is perhaps no condition of contraction, the treatment of which so much requires facility in the employment of orthopædic practice, as does that of Dupuytren's contraction of the fingers.

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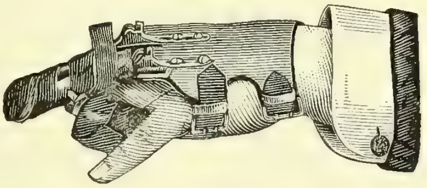
[1] It may be stated that the gentleman here referred to was in the habit of keeping horses that required to be really driven, and not merely guided.

Taking, for the purpose of description, a case similar in its nature to that illustrated in Fig. 0035, the operation is commenced by first dividing the contracted bands of fascia which are present in the palm, and afterwards dealing with the prolongations upwards to the phalanges. An anæsthetic must always be given unless there is some grave objection to its administration; in the first place the operation is a very painful one, and in the second it is very necessary that the hand should be kept perfectly still, and that the surgeon should have complete command of his knife. The knife used must be one with a very small blade and a straight-cutting edge; the fascia is first divided as near the wrist as can safely be done without risk of wounding the superficial palmar arch. The puncture is made about an eighth of an inch to the ulnar side of the contracted band; the blade is worked forwards between the skin and the fascia, and when the band is quite covered by the knife, the edge is turned and the fascia is divided. Care must be taken not to depress the point of the knife so as to wound the digital arteries or the flexor tendons; but of this there is little danger, as the contracted fascia is tensely strained across the hand, and is quite a quarter of an inch above the deeper structures. Having perfectly freed the contraction at this point, the wound is covered with a small pad of lint or other material, and pressure is kept up by the finger of an assistant. A second section is made about midway between the first incision and the base of the flexed finger, the same mode of procedure being followed. These two incisions will probably completely overcome the contraction in the palm, but if necessary a third or fourth must be made, until this part of the hand is quite relaxed. The surgeon will best assure himself of the completeness of this part of the operation by extending the fingers as far as possible, and carefully feeling with the point of the finger for any small fibres of fascia that may have escaped his notice. Having completed the palmar portion of the operation, the pads over the wounds are fixed by strapping; extra pressure is made by a few large pads over the smaller ones, and the whole are firmly, not tightly, secured with a bandage. The prolongations to the fingers are next divided; usually, lateral bands will be found on each side of the first phalanges, and must be divided by separate incisions, each cut being closed as soon as the section is completed, as was done in the palm. The first phalanx should now be capable of being brought into its normal position with the hand; if the second phalanx is drawn down upon the first, more lateral bands will be found extending to its base, and must also be divided. The pads on the wounds are next secured, and the bandage is carried round the fingers that have been operated upon. A flexible metal splint, long enough to reach about three inches up the forearm, and to the ends of the fingers, is next applied as in the case of tenotomy; the fingers may be straightened as far as can be done easily, but it is not desirable to attempt to get them quite straight at this stage. The extra-pressure pads may be removed on the day following the operation, but no haste should be exhibited to take off the small pads which close the wounds; these may be taken from the fingers on about the fourth or fifth day, and from the palm on the seventh or eighth day.

On the fourth or fifth day after the operation, mechanical treatment must be commenced. The construction of the instrument to be used will be best understood from the accompanying illustration; it is attached to the back of the hand, and consists of a plate covering the dorsum, to which are attached steel pieces with extension-racks corresponding to the joints of the fingers; straps for fixing the appliance are also added. The extension must be carried on as rapidly as possible, but great care must be exercised not to cause sloughing of the skin by using too much pressure; it is just at this point that the mechanical ability of the surgeon will be tested: if he proceed too hastily, the skin will give way, and time will be lost in waiting for the sloughs thus caused to heal; whilst if too slow progress be made, recontraction will take place before the fingers are fully extended. In an ordinary case, such as that here being considered, the normal extension of the fingers should be obtained in about three weeks. After this stage is reached, the instrument should still be worn for a time, or a lighter form of apparatus may be substituted for it. Some stiffness of the fingers will remain after the contraction is overcome, but this is soon removed by soaking the hand in hot water, and rubbing it freely with neat's-foot oil or some similar lubricant. When more than two fingers are badly contracted, it is desirable to commence treatment by operating on only a portion of the hand; thus, if the whole of the hand is affected, the thumb and index finger may first be freed, and the remaining fingers treated after an interval of two weeks.

Fig. 1501.



Instrument for Dupuytren's finger-contraction. (After Adams.)

Dupuytren's contraction, like all other forms of contraction with which we have to deal, will relapse if the section of the shortened bands is not thoroughly effected at the first operation, or if the mechanical treatment is not systematically proceeded with. If carefully carried through, the treatment of these cases always yields a most satisfactory result. An interesting feature is the very thorough manner in which nature removes the hardened and contracted tissues; not only does the fascia become reduced to its normal condition, but the thickening of the skin also disappears, a result which is probably due to the free division of the tissues which is involved in the operation.

Lateral Curvature of the Spine.

The subject of lateral curvature of the spine is one upon which much has been written, and upon which many different opinions have been expressed. The etiology of this deformity has never been clearly made out, a failure which has been ascribed to the fact that, as the disease is one essentially of a chronic nature, the investigator has to encounter the serious difficulty of being unable to obtain for necroscopic examination a spine in the early stage of the affection; whether or no this explanation be correct, the fact remains that no two writers on this subject will be found in complete accord, and as a result of this diversity of opinion upon the causation of the deformity, an equal want of harmony exists with reference to its treatment.

Lateral curvature of the spine is of very frequent occurrence, the subjects most liable to the deformity being females, in whom there would appear to be a special tendency to the formation of curvature at two periods of life: first, during early childhood, and secondly, during early adolescence. Except that it may be considered a disease which especially affects civilized communities, it is not limited to any particular class of humanity; it is generally said that the complaint is principally to be met with amongst the better classes, and therefore in those addicted to habits of luxury; but there can be no doubt that the poor are frequently the subjects of lateral curvature: of the three thousand cases of deformity already alluded to as having been classified from the patients attending the National Orthopædic Hospital of London, in 937 there were affections of the spinal column, and of these 353, or nearly 38 per cent., were examples of lateral curvature.

Nature and Characteristics of Deformity in Lateral Curvature.—The spine is liable to become curved laterally either in the cervical, dorsal, or lumbar regions, but the most frequent seat of curvature is in the lower two-thirds of the column, that is, below the fourth dorsal vertebra. The situation and condition of distortion are greatly varied in different cases; thus there may be one long curve extending through several vertebræ, with another short curve; or there may be two curves of equal length, and so on; but in whatever part of the spine the curvature may be located, the structural changes at the seat of curvature will invariably present the same characteristics, and will differ only in degree. The changes in the condition of the spine which constitute the deformity are well marked; it will be convenient to inquire first what are these changes, and to examine the morbid anatomy of lateral curvature, before considering the symptoms and appearances presented during life; for much confusion has arisen from a want of discrimination between other affections in which lateral deflection of the spine exists, but which differ most materially in their nature from true lateral curvature.

Pathological Anatomy of Lateral Curvature.—The condition of the spine when curvature has been formed, is somewhat remarkable; if the anterior surface of the column be examined, it will be found that the vertebræ are displaced from the median line, the extreme point of deflection being usually at the middle of the curve. The natural relations of the bodies of the vertebræ, throughout the curve, are so altered that their surfaces on the side of concavity are brought abnormally close together, whilst on the convex side they are unduly separated—a condition which is the natural consequence of the bending of the column. In addition to this, the vertebræ are changed in position in such a manner that their anterior surfaces are directed laterally, and face towards the convexity of the curve instead of directly forwards. On examining the posterior surface of the spine, the curve will be found to be much less marked than on the anterior surface, and the lateral displacement of the spinous processes will not be proportionate to that of the bodies of the vertebræ. This excess of displacement of the anterior portion of the column is commonly described as "horizontal rotation of the vertebræ," from the fact that the segments of the spine present the appearance of being turned around on their axes.[1] From the occurrence of this peculiar condition of distortion, the spine looks as though it had been twisted, wherefore the use of the term lateral curvature has been objected to, and others, such as serpentine curvature, rotary curvature, and rotato-lateral curvature, have been suggested; it is hardly worth while, however, to give up a term which has become established by use, merely to adopt a phrase which more fully conveys by its meaning the precise nature of the deformity; and indeed the term lateral curvature is not incorrect, for the twisted appearance of the column is simply due to the anterior portion of the spine being displaced to a greater degree than the posterior.

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[1] The term "rotation of the vertebræ" is open to objection, but it has become established by use, and will be employed in this article to express the condition to which it has been ordinarily applied. The reasons for objecting to the term are referred to under the subject of etiology of lateral curvature.

The disturbance of the relative positions of the vertebræ at the seat of curvature, of necessity affects the direction of the transverse processes: these become on the convex side of the curve directed backwards and separated from one another; on the opposite side they are thrown forwards and brought into closer apposition. The articulating processes are also influenced by the change in position of the several bones, for the weight of the body is no longer carried directly through the bodies of the vertebræ, but is directed laterally, and an undue amount of force is brought to bear upon the articular processes on the outer side of the curve; it will readily be understood that under this extra pressure these processes give way and become absorbed, since at the period of life at which curvature is formed they are not fully developed, and have but little power of resisting the strain to which they are subjected.

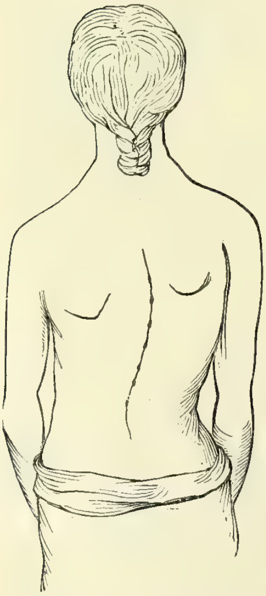
Changes in Intervertebral Disks.—The changes which are found in the soft parts of the column can be described in a few words, but although thus capable of being briefly noticed, they are, as respects the condition of the intervertebral disks, well worthy of consideration. These bodies being firmly united to the surfaces of the vertebræ between which they are interposed, are rotated in a similar manner with the vertebræ at the curved portion of the column; they also become compressed on the concave side of the curve and stretched on the opposite side, so that they are wedge-shaped from side to side, the base of the wedge being on the side of convexity. Together with this change in shape, it is highly probable that their physiological function is interfered with, and that they do not possess that elasticity which pertains to them when in the normal state. Of the other ligaments of the spine, those connecting the transverse processes—the inter-transverse—are the strongest of the lateral ligaments of the column; they are shortened on the concavity and lengthened on the convexity of the curve; and the same condition exists in the fibrous bands which connect the bodies of the vertebræ and form the lateral ligaments of the spine.

Classification of Cases.—These then are the chief points to be noticed in the anatomy of lateral curvature; the external characters of the deformity in the living subject, and the effects produced upon the body by these changes in the structure of the spine, have next to be considered. In describing the external characters of lateral curvature, it is customary to classify the cases according to the nature of the displacement. The method usually adopted of grouping cases under the nomenclature of single curvature, double curvature, triple curvature, etc., according to the number of curves formed in the column, is decidedly open to objection; in no two instances will the condition of curvature present precisely similar features, so that if several cases of so-called double curvature are compared, they will be found to differ greatly in character. Some arrangement is, however, necessary for the convenience of description, and perhaps the most practical way of treating the subject will be to make a regional classification, and to consider first the condition presented by the formation of curvature in the lower two-thirds of the spine, which, as before stated, is the most frequent seat of deformity, noticing afterwards the more uncommon forms of the affection.

Lateral curvature below the fourth dorsal vertebra consists generally in the formation of two curves, an upper or dorsal curve, and a lower or lumbar curve; but although it is convenient to thus distinguish the two curves by the terms dorsal and lumbar, these descriptive titles are not always accurate, for the upper curve may extend below the dorsal region and include one or more of the lumbar vertebræ, or again the lumbar curve may include some of the lower dorsal vertebræ. It is this variation in the length of the curves which gives rise to such a marked difference in the external characters of cases of lateral curvature; to describe all the varieties which the deformity may assume would be impossible, but an examination of the condition presented in three types of the affection will give a fairly representative analysis of the changes which result from curvature of the spine below the fourth dorsal vertebra.

The three conditions of deformity most frequently met with, differ as to the length of the curves in that, in the first, the upper curve is longer than the lower; in the second, the proportions are reversed, the lower curve being longer than the upper; and in the third, the curves are about equal in length. These three classes of cases show certain differences in their external characters: in each the curvature of the spine alters considerably the shape of the trunk, for the vertebral column, like the keel of a ship, is the foundation of the structure, but in the two classes which present an unequal length of the curves the changes are most marked, and of these two the greater deformity results in the first class, in which the upper curve is larger than the lower.

Fig. 1502.



Lateral curvature of spine: long upper curve.

1. A case of lateral curvature in which a *long upper curve* to the right side and a *short lower curve* to the left have been formed, is represented in Fig. 1502; the most obvious change, and the one that first attracts notice, is the *want of symmetry presented by the contour of the body*, so that the outlines of the two sides are markedly different, and on neither is the natural shape of the body preserved. On the right side the wall of the thorax is unnaturally bowed out, whilst the hollow of the flank is abnormally deepened; on the left the whole side is flattened, and the outline exhibits a shallow curve from the arm to the hip; the right shoulder is also higher than the left, and the right hip more prominent. This disturbance of the due proportions of the trunk is caused chiefly by displacement of the ribs, and a consequent alteration in the shape of the thorax; in reviewing the pathological anatomy of lateral curvature it was noticed that the transverse processes of the "rotated" vertebræ were on the convex side directed backwards, and on the concave side thrown forwards; in the dorsal region the altered direction of the transverse processes throws back the ribs on the convex side of the curve, causing their angles to bulge out posteriorly, whilst their shafts and sternal extremities are drawn backwards, giving rise to a depression of the walls of the thorax in front. On the concave side of the curve the reverse conditions exist, the angles of the ribs are carried forwards so that the posterior wall of the chest is flattened, the shafts of the ribs are pushed forwards, the costal cartilages become bent, and an undue *prominence of the thorax* is the result. The condition of displacement here

Fig. 1503.

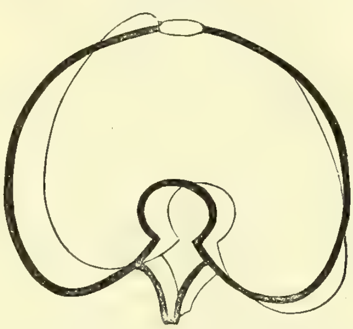


Diagram of thorax in lateral curvature. (After Shaw.)

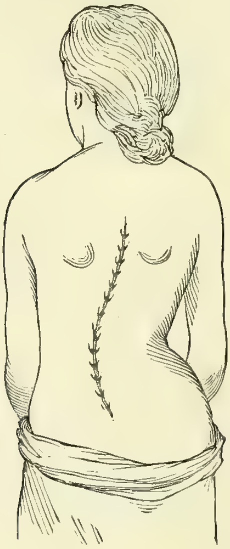
described will be more readily understood by referring to the accompanying diagram (Fig. 1503), in which the dark line represents the normal outline of the thorax on transverse section, and the lighter line the change produced by the altered position of the vertebræ in lateral curvature. A further change in the position of the ribs is also produced, which affects the shape of the thorax: on the concave side of the curve their oblique direction is exaggerated, and they become crowded together and pushed downwards so that the last rib is brought abnormally near to the crest of the ilium; on the convex side the oblique direction is lost and the ribs are directed horizontally, the intercostal spaces being widened and the capacity of the chest apparently increased.

The deepening of the flank on the right side and the flattening on the opposite side, are dependent upon the displacement of the lumbar vertebræ, the bodies of which are turned towards the left side, whereby the abdominal walls fall in on the right side and give an appearance of *undue prominence of the crest of the ilium.* The apparent protrusion of the right ilium is commonly spoken of as "growing out of the hip;" it often first attracts the attention of the patient, and is the cause for which relief is sought from the surgeon; the latter should not of course be deceived by this condition, but mistakes are occasionally made, such as treating the case as one of hip-joint disease, or ordering a high boot to be worn under the supposition that the leg is shortened.

Besides these changes in the outline of the trunk, there are important features to be noticed with reference to the surfaces of the body: on the posterior surface, to the right of the lumbar spine, a groove is formed from the altered direction of the transverse processes; this depression results from the *muscles sinking in* with the rotated transverse processes, and not, as sometimes supposed, from wasting of these muscles; on the left side, in the corresponding region, there is found a prominence caused by the muscles being thrown into strong relief and pushed backwards by the projecting processes on this side. In the dorsal region, the most striking abnormality is the position assumed by the *scapulæ:* the right scapula is unusually prominent, and is directed outwards, its lower angle being especially noticeable—a condition which is due to the altered shape of the thorax, and to the bone slipping above the upper borders of the latissimus dorsi muscle; on the left side the scapula is less prominent than natural, owing to the flattening of the thorax; its inferior angle is depressed, and is on a lower level than the bone of the opposite side. On the anterior surface of the body the changes are not as well marked as on the posterior surface; the *breasts* will, however, be often found to be placed unsymmetrically, the left being more prominent and raised higher than the right; a peculiar twisted appearance of the *abdomen* is also met with, the *umbilicus* being displaced from the median line, and there being a greater fulness on the right than on the left side. The chief variations from the normal condition on the surfaces of the body will thus be seen to be, an undue prominence of certain parts on one side and a depression of the same organs on the opposite side; of these conditions, the first, it will be noticed, arises on the convex side of the curve of the spine on the posterior surface, and on the concave side of the curve on the anterior surface, whilst the depression occurs on the side corresponding to the concavity of the curve on the posterior surface, and on the convex side on the anterior surface.

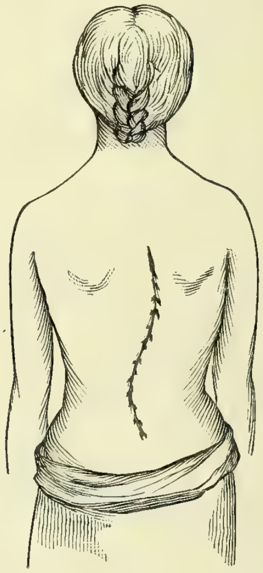
2. The external appearance presented by a case of lateral curvature in which the *lower curve is longer than the upper*, is illustrated in Fig. 1504; the upper curve is to the right side and extends from the fourth to the ninth dorsal vertebra, where the left curve begins and involves the rest of the column below. The contour of the body exhibited in this case, compared with the condition present in Fig. 1502, shows that increase in the length of the lower curve produces greater distortion of the lower part of the body, and that the shorter curve above gives rise to less deformity of the chest and shoulders. The flank on the right side is deepened to a very marked extent; on the left side the normal curve is almost entirely lost; in the upper part of the body the right shoulder is only slightly raised, and the right side of the chest is much less prominent. A like variation in the effects produced by the curvature will be found on the posterior and anterior surfaces: the ridge on the left side of the lumbar spine is larger and more marked, whilst the depression on the right is to the same degree increased; the positions of the right scapula and of the left breast are scarcely altered.

Fig. 1504.



Lateral curvature of spine; long lower curve.

Fig. 1505.



Lateral curvature of spine; equal curves

3. The conditions existing in the above cases show that deformity of the body is proportionate to the length of the curve in the spine; the longer the curve the greater is the distortion, and *vice versa;* in the third state of curvature, where the two *curves are nearly equal in length*, there is therefore less distortion of the trunk, because neither of the curves involves many vertebræ in its extent. In the case illustrated in Fig. 1505, two curves of about the same length have been formed, the upper to the right and the lower to the left side; the right shoulder is but slightly elevated and the flanks are not seriously affected; in fact, to avoid repetition, it may be stated

that the same general condition of deformity will be found as exists in the dorsal region in Fig. 1502 and in the lumbar region in Fig. 1504, only to a much less degree.

The three cases which have been selected as types of the three conditions of deformity, below the fourth dorsal vertebra, all present an *upper curve to the right* and a *lower curve to the left side*, and, as has already been stated, this is the usual direction of the respective curves; such is not however a constant feature of lateral curvature of the spine, for the opposite state may occur of a dorsal curve to the left and a lumbar curve to the right side. When this latter condition of curvature is present, the distortion of the body will be correspondingly reversed, and those changes in the thoracic and abdominal regions which have been noted in the cases illustrated, will be found on the opposite sides of the body.

In the greater number of cases of lateral curvature, the deformity is confined to the lower two-thirds of the spine, but in some few instances the *upper third of the column* is also distorted. Early childhood and early adolescence have already been noticed as the periods of life at which curvature usually commences; deformity developed at the later period very rarely extends to the upper dorsal and cervical vertebræ; it is in cases which commence in early childhood that curvature in this region is occasionally met with. The structural changes in the upper part of the column, when curvature has been formed, are of precisely the same nature as those already described as occurring in the dorsal and lumbar regions; there is the same twisting of the vertebræ, with greater lateral displacement of their bodies than of the spinous processes, and the same altered relationship of the surrounding structures as a result of this displacement. The upper cervical region is never the seat of curvature except as a complication of wry-neck, with which deformity this condition will have to be considered. Idiopathic curvature may extend as high as the sixth cervical vertebra; in such a case, it is as a rule the beginning of a long upper curve extending to the lower dorsal vertebræ, from which point a second curve to the opposite side will be found involving the vertebræ below. In exceptional cases there may be a short curve above, then a second curve to the other side, and a *third curve* below, to the same side as the first; these three curves may exhibit all sorts of variations in their respective lengths. Even *four curves* may be developed, and the existence of such conditions as these has led to the grouping of cases of lateral curvature of the spine according to the number of curves found in the column; but such a classification only tends to promote confusion, and to withdraw attention from the fact that the length of the curves—the number of vertebræ consecutively distorted—is the character of deformity of chief importance.

The description that has been given of the various forms of curvature, both with regard to the structural changes in the column and the external characters presented, has reference only to that state of deformity in which the curves formed have been well marked but not of severe grade; it still remains to examine the course which the deformity follows from its first appearance to its most advanced stage.

PROGRESS OF LATERAL CURVATURE.—In the development of lateral curvature the anterior portion of the column is first deflected from the median line; the vertebræ at the seats of curvature commence to rotate, so that their bodies are turned to one side, which eventually becomes the side of convexity of the curve, whilst the spinous processes retain their normal positions. As the distortion increases, the bodies of the vertebræ become further displaced, and it is not until the curvature is well advanced that lateral deviation of the spinous processes occurs; these parts of the vertebræ may remain in position when even an extreme degree of lateral displacement of the bodies exists. This resistance to the formation of curvature displayed by the posterior portion of the spine, is especially exhibited in the lumbar region, where the apices of the spinous processes seldom become displaced, and are never so to more than a slight degree. The evidence of existing mischief is thus not very clear in the first stage of lateral curvature: the most superficial parts of the column are not affected, and the slight deflection of the bodies of the vertebræ has not yet produced any marked effect upon the surrounding structures. In the dorsal region the curvature is usually first detected; the increasing rotation of the vertebræ, and the consequent displacement backwards of the transverse processes and ribs on the side of convexity, cause the scapula on that side to become unduly prominent, and, as the deformity advances, the shoulder to be raised above its fellow on the opposite side. At the same time the flank becomes slightly deepened on the concave side of the lumbar curve, a change which does not attract the attention of the uninitiated observer, but which should be carefully looked for in this stage of deformity. Seldom, it may perhaps be said never, is a case of lateral curvature presented to us for treatment until it has reached the condition just indicated; only too frequently the deformity is allowed to advance further, because the slight defects noticed are considered of no importance. From the state now reached, the progress of the distortion, if not checked, becomes more rapid; in a few weeks, one or other of the conditions which have been described as illustrating the three types of lateral curvature (Figs. 1502 1504, and 1505), is developed. Still advancing, a grave deformity is established which has the effect of seriously diminishing the cavities of the thorax and abdomen, and of thus mechanically obstructing the action of the viscera.

It is the *thorax*, the walls of which are more intimately connected with the spine than are those of the abdomen, that chiefly suffers from the distortion of the column in lateral curvature. This cavity is seriously diminished on the convex side of the dorsal curve, first by the encroachment of the bodies of the vertebræ, which are turned towards this side, and secondly by the change in the shape of the ribs. The displacement of the ribs backwards, gradually increases as the rotation of the vertebræ advances; being held in front by the sternum, which through its attachment to the clavicles prevents much lateral displacement of the anterior extremities of the bones, they are subjected to a constant strain which effects a marked change in the form of their shafts; they become as it were folded up, and shaped somewhat like the bend of a fish-hook. The thoracic cavity is thus contracted laterally, and is flattened in front, on the convexity of the curve; it is slightly increased posteriorly, but the advantage gained here is considerably diminished by the pressure of the bodies of the vertebræ. On the concave side of the curve the ribs are pushed forwards, the chest on this side being contracted behind and somewhat enlarged in front; the chief mischief on this side is found in the loss of space in the vertical direction, as the ribs are crowded together and pressed downwards, whilst their oblique direction is increased to such a degree that the last rib will often touch the crest of the ilium. This distortion of the walls of the thorax is in itself sufficient to account for the presence of impeded respiration and defective action of the heart, in cases of severe lateral curvature, but other causes of these conditions also exist: the mechanism of the costo-vertebral articulations is thrown out of gear, and the rising and falling action of the ribs is much diminished; moreover, the abdominal viscera are pressed against the diaphragm, so that in every direction is the expansion of the thoracic cavity interfered with.

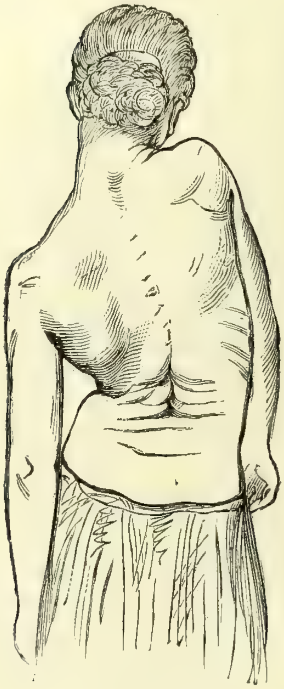
The *abdominal viscera*, when the curvature is severe in the lower dorsal and lumbar parts of the spine, are much affected by the limited space in which they are inclosed. The walls of the abdomen, being flaccid, can to some extent accommodate themselves to the shortening of the spinal column in this region; the front of the abdomen becomes protuberant, but the sides are compressed by the descending ribs, especially on the convex side of the lower curve. The chief trouble that results is from compression of the liver and stomach, giving rise to sickness, constipation, and other symptoms of disordered digestion. This mechanical derangement of the abdominal and thoracic cavities renders severe lateral curvature a most formidable complaint.

The amount of relative distortion of the chest and abdomen will depend upon the nature of the curves; the severest condition of thoracic contraction occurs when the dorsal curve commences high up in the column and extends through the whole of the dorsal region; the abdomen will be most compressed when the lower curve commences in the middle of the dorsal region and extends to the last lumbar vertebra. The former condition, of severe deformity of the thorax, is the graver complication of the two: exercise becomes almost impossible; shortness of breath, palpitation of the heart, and giddiness, all arise at the slightest attempt at exertion, and often the patient is unable to lie in the recumbent position; hæmoptysis may terminate an existence which is scarcely endurable.

Diagnosis of Lateral Curvature.—The diagnosis of lateral curvature, owing to the characteristic nature of the deformity, would appear to be an easy matter; such certainly is the case if the surgeon clearly appreciates the fact that lateral curvature, much as it varies with respect to the situation and length of the curves formed, is always to be distinguished by the structural changes which occur at the seat of deformity. Unfortunately this important point is too often lost sight of, and other conditions of the spine, in which deviation of the column to one or other side is present, are confounded with true lateral curvature. To avoid this error, it should be remembered that the constant feature of true lateral distortion is greater displacement of the anterior portion of the column than of the posterior—the rotation of the vertebræ which has been so frequently alluded to. With this fact before us, an error of diagnosis is scarcely possible, except perhaps in the early stage of the affection; but before endeavoring to decide in what manner the commencement of curvature is to be detected, the spurious conditions of lateral curvature must be reviewed.

A state of lateral deviation of the spine that is very generally mistaken for lateral curvature, is met with in growing girls who live in a condition unfavorable for the healthy development of their bodies; the maid-of-all-work of the small tradesman, the drudge of the cheap lodging-house, school-girls economically received at "establishments"—all such as are overworked and miserably fed—are very commonly found to present lateral deviation of the spine when examined in the upright position. Nor is this condition peculiar to the class above quoted; the weakening effect of acute illness, disordered digestion with imperfect assimilation of food, and all those states of defective health which are so conveniently described as "general debility," may give rise to a weakened condition of the spine in young girls of any class of life, and produce the same result. This condition is at once distinguishable from true lateral curvature, for no structural change of the spine is developed; if the subject, when under examination in the erect position, is directed to stoop forwards without bending the knees, the spine will at once lose its lateral deflection, and the same occurs when the horizontal position is assumed. There is then, in such cases, merely lateral deviation of the spine from want of power to keep the column erect; not that such power is entirely lost, for by a slight effort the muscles may be made to bring the column straight, although relapse immediately occurs as soon as the extra muscular exertion is withdrawn. In true lateral curvature, in whatever position the subject is placed, the distortion of the spine remains, and no amount of muscular exertion will do away with the deformity. For want of a better descriptive term, this spurious state of lateral curvature may be alluded to as lateral *bending* of the spine, reserving the term *curvature* for deformity accompanied by structural changes in the column.

Fig. 1506.

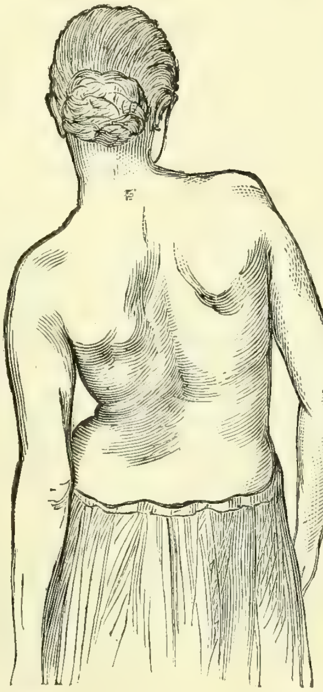


Lateral bending of spine.

The external appearances of *lateral bending of the spine* are illustrated in Fig. 1506. which shows an extreme degree of distortion of the body in a girl aged 18; in this case the spine and trunk became perfectly straight when the horizontal position was assumed, and the girl could straighten her spine, when in the erect position, by placing her hands on her hips and forcing up her shoulders. If this case is compared with that illustrating lateral curvature with a long upper curve (Fig. 1502), a difference in the contour of the body, which at once distinguishes between the state of lateral bending and that of lateral curvature, will be observed. In the case of curvature, the raised shoulder and the deepened flank are on the same side of the body; here the right shoulder is raised and the left flank is depressed—the spine has as it were toppled over to the left. Lateral bending of the spine seldom reaches such a severe degree of deformity as was present in this patient; usually there is merely a slight bending of the spine to one side, which is readily relieved by attention to the general health; if, however, the true nature of the affection be not recognized, and if local treatment alone be adopted, as in the case of this girl, the deformity will continue to increase.

That a case of *Pott's disease of the spine* should be mistaken for one of lateral curvature, would appear hardly possible, yet such an error has come under my notice on more than one occasion. When caries chiefly affects one side of the bodies of the vertebræ, the column gives way towards the side of greatest destruction, and a decided condition of lateral deflection becomes established. There is in these cases a feature which should prevent any error in diagnosis; the spinous processes are always unduly prominent, and the condition of angular deformity coexisting with the lateral displacement marks clearly the real nature of the case. Lateral deflection of the spine may, however, be the first symptom of commencing mischief in the early stage of Pott's disease, before destruction of bone has occurred; in such a case the affection may very excusably be supposed to be merely lateral bending of the spine. Fig. 1507 illustrates an example of this condition. The subject was a girl aged 19, who was in a weak state of health and had been working as a general servant; the external appearances of the trunk presented a very similar state of deformity to that exhibited in the case of lateral bending shown in Fig. 1506. The deformity entirely disappeared when she was placed in the recumbent position, and also when stooping, and a careful examination could detect no abnormality of the spinal column, either with respect to its mobility or to the position of the vertebræ. The case was accepted as one of weak spine with lateral bending, and was treated accordingly. Having been a few weeks under treatment, she complained of pain at the seat of the second lumbar vertebra, and there was then found to be some rigidity of the spine at this spot; recumbency was ordered, and all other form of treatment withdrawn; at this time the photograph from which the accompanying illustration is copied was taken; in the wood-cut, the letter *A* marks the situation of decreased mobility and pain. In three weeks' time there was slight prominence of the spinous processes of the second and third lumbar vertebræ, and the case was clearly demonstrated to be one of Pott's disease of the spine. The chief interest attached to this case belongs rather to the diagnosis of the early stage of caries of the vertebræ, than to that of lateral curvature; but it is nevertheless instructive as showing the difficulty which occasionally attends recognition of the true nature of an affection of the spine accompanied by lateral deviation of the column.

Fig. 1507.



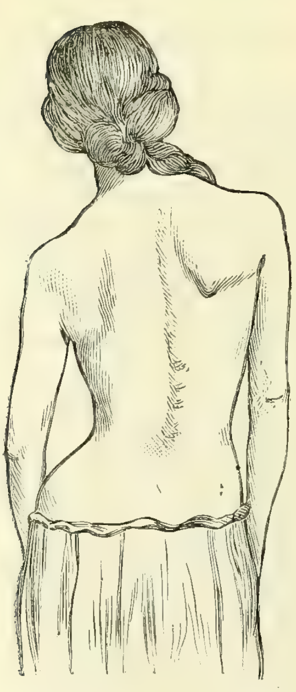
Lateral deflection of spine in early stage of Pott's disease.

It has already been remarked that, in the diagnosis of lateral curvature, some difficulty may be experienced in detecting the early stage of the deformity; as it is of course of the highest importance that the commencement of curvature should be recognized, it is necessary to be acquainted with the possible sources of error that exist. It is by no means uncommon for lateral bending of the spine, occurring to a slight degree, to be mistaken for lateral curvature, and also for the latter to be regarded as mere lateral deviation of the column from weakness; such want of discrimination has been frequently brought under my observation, either in hospital practice or in the examination of patients applying for surgical appliances to one of the London charities. In the early stage of both affections, there is no deviation of the spinous processes when the patient is lying down or bending forwards, and it may be here remarked that no just conclusion can be arrived at if the subject is only examined when erect. The history of the case is to some extent a guide to the surgeon; in lateral bending of the spine, there is always to be traced some cause of bodily weakness such as was described when considering the nature of that affection, but lateral curvature may be and indeed generally is preceded by no conditions that have produced debility. Again, the attitude of the patient when standing is worthy of notice; in the atonic lateral deviation of the column, the subject stands in a weary, drooping manner, the head is bent forwards, and the arms hang listlessly by the sides; in lateral curvature, on the contrary, the arms are usually kept erect, and tend rather to brace up the muscles of the back and give rigidity to the trunk. In both conditions of the spine there may be present some slight difference with regard to the scapulæ, the bone on one side being a little more prominent and rather higher than its fellow; the shoulders, too, may be somewhat uneven, the one being raised rather above the level of the other. In the case of lateral curvature, these differences, when existing, will be persistent in spite of the efforts of the surgeon to correct them: if the depressed shoulder be pushed up, it will directly resume its former position on being released, and the prominence of the scapula will not be corrected except by altering the position of the arm; in lateral deflection, however, these malpositions can be corrected by the efforts of the patient herself, and by muscular action.

Having observed the conditions presented when the subject is in the erect position—standing, that is, with the feet together, the legs straight, and the arms by the sides—the spine must next be examined when bent forwards. The patient should be directed to stoop, bringing the shoulders about on a level with the pelvis, without bending her knees; the surgeon then, with the fore-finger of each hand, carefully feels along each side of the spinous processes from the first dorsal to the last lumbar vertebra, in order to ascertain if in any part of the column there is a greater fulness on one side than on the other. The slightest deflection of the bodies of the vertebræ to one side will be at once detected by this examination: on the side towards which rotation has commenced, the transverse processes will be turned a little backwards; on the opposite side they will be directed forwards; digital pressure will reveal a slight fulness in the former and a corresponding depression in the latter situation, at the seat of commencing curvature; but when no rotation is present, the furrows on each side of the spinous process will be exactly similar, and that the case is merely one of lateral bending of the spine may be confidently declared.

The differences between lateral curvature and lateral bending of the spine are clearly such as should prevent any difficulty in recognizing the respective conditions of deformity, but it occasionally happens that the two are found combined in the same person, when it becomes necessary to distinguish to what degree the distortion depends upon structural change, and what share in the case is to be ascribed to spinal weakness. Such a case is illustrated in Fig. 1508, taken from a young girl aged seventeen, who, for about two years before the condition here represented had been reached, had suffered from deformity of the spine. The external appearances exhibited here, show much the same nature of deformity as do the case of commencing Pott's disease (Fig. 1507) and that of lateral bending (Fig. 1506); if the three cases are compared, they might very naturally be supposed to represent three stages of the same condition of distortion, yet each is an example of a different state of lateral deviation of the spinal column. The patient here referred to had been treated for some length of time for lateral curvature, but the method employed was unsuitable for her condition, and lateral bending of the spine was developed in addition to the curvature; the reasons for this unfortunate result will have to be referred to when the question of treatment is under consideration; for the present, we are concerned only with the existing complication of two conditions of distortion. This two-fold displacement of the column is also met with in

Fig. 1508.



Combined lateral curvature and bending.

subjects who are afflicted with lateral curvature, the development of which is accompanied by debility, or who, being already afflicted with curvature, are exposed to causes which induce a weak state of health, and give rise to lateral bending of the spine in addition to the previously existing structural deformity. The analysis of such cases is quite simple: we have only to note the condition of the spine and trunk when the patient is standing up, and then to observe the effect produced by causing her to stoop forwards; the differences of deformity existing in these two attitudes will be the amount depending upon lateral bending, the permanent state of distortion when the spine is bent being alone due to lateral curvature. In the case shown in Fig. 0044, there was marked rotation of the vertebræ to the right side from the third to the eleventh dorsal, and the same condition towards the left side from the twelfth dorsal to the last lumbar.

Etiology of Lateral Curvature of the Spine.—The great diversity of opinion that exists upon the subject of the causation of lateral curvature, has already been alluded to, and it has been noted that this want of concord has been ascribed to the fact that in the investigation of this question the surgeon, being unable to obtain for necroscopic examination a spine in the early stage of deformity, is compelled to a great extent to base his theories upon speculation. It is, however, probable that were this difficulty removed, post-mortem examination might lead to no satisfactory results, for the changes which occur in the spine and surrounding structures are essentially such as belong to vital action, and even the microscope might fail to detect changes which nevertheless, during life, seriously influenced the functional properties of the affected tissues. It is scarcely necessary to point out that, in spite of all the appliances for skilled investigation with which science can supply us, changes do occur in living tissues which, although sufficient to destroy vitality, are yet undemonstrable after death. Of the many theories that have been advanced as to the etiology of lateral curvature, it is difficult to select one that satisfactorily accounts for the development of the deformity; most careful investigation is still required of this subject, and our efforts must be directed to determine whether the distortion is consequent upon changes in the column itself, which render it unfit to fulfil its physiological functions as a supporting column, or whether the curvature results from external influences which act upon the spine and disturb its adjustment, or, again, whether it is a combination of these processes which gives rise to the deformity.

The development of lateral curvature is by recent authors usually ascribed to the action of causes which are not of innate, but of external, origin; by earlier writers the curvature was considered to be dependent upon changes in the bones, variously described as of an inflammatory, rachitic, or scrofulous nature; a better knowledge of the morbid anatomy of this deformity, together with the production of evidence of the fact that curvature often exists in a spine the bones of which are in no way affected beyond being displaced from their normal positions, disproves the truth of these early theories. When referring to the history of orthopædic surgery, it was remarked that the scientific treatment of deformities had been developed from the introduction of subcutaneous tenotomy, which had been first successfully employed in the treatment of club-foot. The fact that the latter distortion was directly dependent upon muscular contraction, led investigators to conclude that other deformities of the body probably arose from the same cause; this no doubt influenced their judgment, and suggested the theory that lateral curvature, not being due to disease of the bones of the spine, was necessarily of external origin, and that of all forces acting upon the spine, none was so likely to produce displacement of the column as that of abnormal muscular contraction.

Various theories have been advanced in regard to the method by which the symmetry of the spine is destroyed by the action of the muscles of the trunk. Spasmodic muscular contraction must be noticed as one of the ascribed causes of lateral curvature, but upon this theory it is not necessary to dwell at any length ; spasmodic contraction of the muscles of the trunk is very seldom met with, and when such does occur, the muscles are generally affected alike on both sides, so that the body is drawn directly backwards and not laterally. Further, it may be remarked that nerve-irritation and muscular spasm are essentially affections of early childhood, whilst lateral curvature is in the large majority of cases developed at a later period of life. The influence of muscular action in the causation of lateral curvature, has been more generally regarded, not as the first, but as the exciting cause of deformity ; as predisposing causes are given, debility—the result of exhausting disease such as scarlet fever—weakness from rapid growth, over-exertion of the bodily strength, irregularity of the menstrual function, the non-observance of proper hygienic rules, and other like conditions which induce a feeble state of health. Such depression of the bodily powers may or may not precede the formation of lateral curvature, but if pre-existing, how the muscles thereupon become the instruments which promote distortion of the spine, is not very clear ; this is shown by the want of agreement amongst authorities who are of one opinion in ascribing the formation of curvature to muscular action, but who differ very much as to the precise manner in which that influence acts upon the spine.

The theory of excited muscular action which obtains the most support, is explained by pointing to the practice which is common amongst young girls, especially those who are not very robust, of adopting bad habits of position, such as standing on one leg and sitting awry, whereby the pelvis is tilted and the spine kept in a condition of curvature. By thus habitually bending the spine in one direction, it is assumed that, on the side towards which the column is inclined, the muscles become shortened, and that contraction of their fibres results, establishing a confirmed condition of deformity. It is well-known that, in the treatment of a fractured limb, if a joint be fixed in the flexed position for a lengthened period, it will become contracted from shortening of the flexor muscles; but we know also that if the joint be moved even once a day to the full amount of its proper extension, such contraction will be prevented. In the case of the spine, even if there be this habit of constantly tilting the pelvis, it must be allowed that frequent changes in the position of the body are assumed, and that the muscles are sufficiently often relaxed to prevent them from becoming permanently shortened; moreover, during sleep the muscles are rested, for although it was formerly argued that by lying on a feather bed the pelvis was kept uneven at night, in these days feather beds are seldom used, and the firmer couch now universally adopted keeps the spine in good position. There is a class of subjects, in whom, when standing, the pelvis is always tilted—those who from some cause suffer from shortening of one lower extremity ; such subjects are declared by many authors to be especially liable to acquire lateral curvature. My own experience is quite opposed to such a statement ; among the many applicants to the Surgical Aid Society of London, investigation has failed to discover the complication of lateral curvature in those who apply for instruments to remedy the shortening of a limb ; this is the more noteworthy because the greater number of these cases are of the very poorest class, suffering from lameness due to disease of the hip-joint, to excision of the knee, to paralysis of one limb, and to various causes which clearly indicate a defective condition of health. If further consideration is necessary before dismissing the theory of acquired muscular contraction, I would refer again to the case illustrated in Fig. 1506, described under the subject of lateral bending of the spine; surely if muscular contraction consequent upon assuming a bad position were the cause of lateral curvature, such a case as this ought to have developed the deformity; yet the spine remained unaffected by structural change, although the distortion had existed for two years.

The formation of curvature by muscular action has also been ascribed to the existence of greater power of the muscles on one side of the body; thus, in the dorsal region of the spine, it has been reasoned that the right lung is more capacious than the left, that the right arm exceeds the left in weight, and that therefore the muscles passing between the spine and the chest and arm, are stronger on the right than on the left side, and that by their action the spine is dragged into a condition of curvature. The serratus magnus muscle is regarded as the principal agent in producing the deformity; by its action upon the ribs it converts these bones into levers, and twists around the neighboring vertebræ. The objection to this theory is that lateral curvature of the spine should, according to this reasoning, be a frequent complication of chronic affections of the lungs, when one lung is more affected than the other; but this is not the case, for the victims of phthisis are very rarely the subjects of lateral curvature; moreover, it is difficult to understand how the serratus magnus muscle could act in the manner described, since it is, through the scapula, directly dependent upon the spine itself for its fixed point for action. One more argument in favor of the muscular origin of curvature may be noticed before leaving the subject; the probability of the muscles of the trunk being chiefly instrumental in developing abnormal curvatures of the spine, has been supported by ascribing to the same influence the formation of the normal antero-posterior curves. The spine of the infant, we are told, is shaped after this manner: the psoas muscles draw forwards the lower vertebræ, the erectores spinæ pull back the column above this point, still higher the vertebræ are again brought forwards by the abdominal muscles, and the normal shape of the spine is completed by those muscles which are attached to the occiput producing by their contraction another curve. Supposing that we accept this hypothetical explanation of the formation of the three normal antero-posterior curves of the column, to what guiding influence are we to attribute this exact modelling by contraction of the various muscles? and having solved this problem, how are we to apply our knowledge so as to arrive at the influence which gives origin to abnormal curvatures? It can scarcely be doubted that, had the muscular-causation theory of the development of lateral curvature never been advanced, the formation of the normal curves of the spine by muscular action would not have been suggested.

The theory of causation which we have next to consider, differs in a most important respect from those already passed in review, for the formation of curvature is ascribed to changes arising within the column itself, these changes being due to certain predisposing conditions. The first predisposing cause is the existence of considerable flexibility of the spine at the age at which curvature is developed; this normal flexibility is unduly increased in young girls by deterioration of the muscular tissue which results from their pursuing a sedentary mode of life, precluding the healthy development of the muscles of the back; as a sequence of this muscular weakness, sympathetic degeneration of the ligamentous tissue ensues. Deprived thus in a great measure of the support which it receives from the muscles and ligaments, the spine is chiefly dependent upon the articular processes for power to resist pressure applied in a lateral direction. If then the subject, with a spine thus weakened, frequently throws the column into a condition of curvature, by standing or sitting in attitudes which tilt the pelvis, structural changes in the spine will occur from absorption of the articular processes, these bony projections being imperfectly formed in youth, and quite unable to resist lateral pressure constantly directed against them. Following this line of argument still further, the conclusion which must be reached is that the amount of structural change within the column will be greatest where the articular processes, from their shape and direction, offer the least resistance to the exciting cause of deformity, because in that region of the spine the obstacles to rotation of the vertebræ will be the more easily overcome; again, in that part of the column where the articular processes are best designed to give lateral support, there rotation will be the least developed, in consequence of the better defence opposed to the destructive pressure. In truth, we find the very reverse of these conditions in practice: in the lumbar region of the spine, the vertebræ are especially protected by the shape of their articular processes against lateral pressure, yet in this situation are to be found the most extreme examples of structural change within the spine without lateral deviation of the whole column; in the dorsal region, the deflection of the bodies of the vertebræ seldom proceeds far before the displacement of the spinous processes takes place, although the resistance offered by the articulating processes to lateral pressure in this region is much less than that presented by the corresponding structures of the lumbar vertebræ.

The various theories most deserving of notice, as being those upheld by authorities of the present day, upon the causation of lateral curvature of the spine, have now been discussed, but the subject has by no means been thoroughly exhausted; the space at my command will not admit of a full analysis of the many speculations that have been put forward, each as the true explanation of the development of this deformity—speculations varying from the simple suggestion that the habit of wearing stays is the origin of the affection, to the more complex theories supported by diagrammatic illustrations and mathematical formulæ. To follow the course of the development of lateral curvature from the first departure from the normal condition to an advanced state of deformity, is a method of investigation which is denied to us; such a progressive examination of the morbid changes in the spine through the various stages of this affection, could by no possibility be the work of one inquirer, unless supported by means of research which no individual is likely to be able to command. In attempting to solve the problem as to the causes on which the formation of lateral curvature depends, we can only rely on our knowledge of the physiological properties of the healthy spine, the nature of the anatomical changes which occur in the deformed column, and the clinical facts which accompany the development of these changes.

With regard to the physiological properties of the spine, we are concerned chiefly with the functions which it fulfils as a supporting column and as the foundation of the skeleton; with its property as a protecting canal which contains the spinal cord, we are not interested. The bodies of the vertebræ and the intervertebral disks form the supporting section of the spinal column, and, as we have seen, these are the parts of the spine which are chiefly displaced in lateral curvature. The structure of the anterior portion of the spine is so designed as to enable the column to bear a considerable weight, and at the same time to permit of the necessary movements of the trunk; composed of alternate layers of light cancellous bone and elastic fibrous tissue, united together by various ligaments, it presents a column consisting of a series of curves and pyramids, and possessing the three attributes of strength, flexibility, and elasticity. The quality of flexibility is not equally distributed throughout the spine: the cervical region possesses the freest powers of movement both in the antero-posterior and lateral directions; in the dorsal and lumbar regions, the range of motion from before backwards is about equal; but in the latter region lateral movement is more limited than in the former. The variation in the amount of movement of which the separate regions of the spine are capable, depends upon differences in the shape and direction of the articular processes, and upon the thickness of the intervertebral disks. The free movements of the cervical vertebræ are gained by the articular processes being so shaped as to permit of a good deal of motion between the bones, apart from that given by the soft intervertebral disks; in the dorsal region, the movement is derived about equally from the intervertebral disks and from the play between the surfaces of the joints on the articular processes; in the lumbar region, the intervertebral disks afford the greatest freedom of movement, the lateral motion being entirely gained from these structures. The property of elasticity possessed by the spine lies wholly within the intervertebral bodies; the structures, on being compressed, have the power of self-expansion, a power that the tissue of which they are composed is not capable of exercising immediately, but which it requires some little time to exert, so as to restore the disks to their full size; the longer the compressing force is applied to these bodies, the slower will be their return to their proper thickness. The loss of length which occurs in the spine of an adult who has been for some hours in the erect position, is due to compression of the intervertebral bodies, the loss amounting to about one inch; after some few hours in the recumbent position this loss is regained by the gradual expansion of the fibrous tissue, so that as the total thickness of all the intervertebral bodies is rather less than four inches, the elasticity of these structures is able to overcome the effect of a pressure which reduces them more than one-fourth of their proper size.

The nature of the anatomical changes which occur in lateral curvature of the spine has already been fully described, but attention may again be called to the fact that in the early stages of the deformity the structural defects in the column are limited to the intervertebral disks and ligaments, and that the bones are not altered in shape until the curvature is in an advanced condition.

The clinical characteristics of lateral curvature may be summarized as follows:—

(1) It commences at one of two periods of life, early childhood or early adolescence.
(2) It affects girls much more frequently than boys.
(3) It is not of traumatic origin, nor is its onset accompanied by any local symptoms which indicate the presence of active morbid changes in the structures of the vertebral column.
(4) It may be associated with debility and with muscular weakness, but it not unfrequently occurs in subjects who are robust and strong.
(5) It is often combined with defective menstruation when commencing at the age of puberty.
(6) It prevails in certain families, and is often hereditary.

In reviewing the various theories which ascribe the development of lateral curvature to the influence of external agents, such as muscular action, an attempt has been made to point out in what respects these theories fail to satisfactorily account for the origin of the deformity; so also objection has been made to the explanation which refers to absorption of the articular processes the formation of confirmed curvature. In attempting to solve the important problem of the etiology of lateral curvature, attention must be especially directed to the fact that mere constant bending of the spine to one side will not induce a condition of structural change; so that there must exist, also, within the column itself, some contributory defect without which lateral curvature will not become developed. As to the particular nature of the defective condition of the column which conduces to the development of lateral curvature, it is impossible to give a decided opinion, but in all probability the ligaments and intervertebral disks are the seats of mischief.

For the sake of definition, let it be taken for granted that these structures are wanting in their normal qualities; the spine would then be affected in two of its principal properties, viz., flexibility and elasticity. The flexibility of the spine is chiefly restricted by the ligaments which connect together the several vertebræ; if these ligaments have lost their normal tenacity, the flexibility of the spine must be increased; again, the column derives its elasticity from the intervertebral disks, and if the tissue of these structures is degenerated the power of elasticity will be lessened. A spine thus unduly flexible and deficiently elastic, will be in just the condition to develop lateral curvature, if the subject is in the habit of standing and sitting in such positions as tilt the pelvis and throw the column into a state of curvature; because the weakness of the ligaments will readily permit of the bending of the column, while the intervertebral cartilages, from their want of elasticity, will be unable to recover from the unequal compression to which they are subjected; thus day by day a gradual deflection of the column will take place, and a state of curvature will become established.

I am not in a position to prove absolutely the theory above offered, that degeneration of the fibrous tissues of the spinal column is the original source from which lateral curvature is developed; the only evidence which could definitively establish this proposition as a pathological fact, would be the demonstration that the ligaments and intervertebral disks in the early stages of lateral curvature, differed in certain structural respects from the same tissues in the healthy column. But the difficulty of making this demonstration is very great; in the first place, it is seldom that an observer has the opportunity of making a post-mortem examination of a spine in the early stage of the deformity, and even when this chance is presented, it is with dead tissues only that he can experiment, rendering the worth of the experiments of very doubtful value; it must be taken into account, too, that the qualities of the tissues, the impairment of which has to be proved, may very well have degenerated without there being any clear indication of structural changes. There is, however, some valuable circumstantial evidence which may be advanced in favor of the above theory; thus, at the periods of life at which lateral curvature commences, the deformities knock-knee and flat-foot are very commonly developed, and indeed these two distortions and lateral curvature may be said to comprise ninety-nine out of every hundred cases of deformity commencing between the ages of ten and twelve years. Now knock-knee and flat-foot, in the great majority of cases, admittedly result from ligamentous weakness, arising respectively from insufficient resisting power of the internal lateral ligament of the knee-joint, and from weakness of the ligaments of the sole of the foot; defect of the fibrous tissues being thus the producing cause of two out of three of these deformities, we may justly conclude that the third is likely to be due to a similar defect, it further being considered that lateral curvature and flat-foot are frequently found to exist in the same subject. Moreover, that loss of elasticity and increase of flexibility in the spine give rise to lateral curvature, would, if admitted, account for the somewhat irregular manner in which this deformity selects its victims; it has been shown that subjects who would seem to possess all the qualifications necessary for the development of lateral curvature, such, for instance, as the patient whose case is illustrated in Fig. 1506, nevertheless escape the distortion; whilst strong, healthy girls, with good muscular organization, and apparently well able to resist the effects of any amount of strain that may be put upon their spinal columns, yet become seriously deformed. In the first case, although the column is constantly kept in a state of curvature during the daytime, the flexibility and elasticity of the spine are such that it recovers during rest, and does not become permanently altered in shape; in the second case, although only subjected to the normal amount of bending, it is, from defective condition of its most important qualities as a weight-bearing column, unable to regain its natural shape, and thus gradually becomes permanently curved.

The cause of the peculiar method of displacement which characterizes lateral curvature, the so-called rotation of the vertebræ, is probably due to the anatomical construction of the spine. The anterior portion of the column —the bodies of the vertebræ—is not provided with much lateral support; whilst its posterior portion—the arches of the vertebræ—is stayed up by numerous muscles and bands of fascia. The anterior portion, being that part of the spine which fulfils the duty of a weight-bearing column, is also especially liable to be affected by the exciting causes of lateral curvature; it is moreover largely constructed of fibrous tissue, and it is not therefore surprising that it should first be deflected from the median line. The varying extent to which rotation occurs in the different parts of the column, is also to be explained by the construction of the intervertebral bodies: it has already been noticed that excess of displacement of the anterior portion of the column over the posterior, is much more marked in the lumbar region than in the dorsal; in the former situation, the relative thickness of the intervertebral disks is much greater, whence the tendency to rotation; also the lateral support which the posterior parts of the lumbar vertebræ derive from the muscles and fasciæ, tends to contribute to their stability. The term rotation of the vertebræ does not accurately define the real nature of the distortion, which consists really of a general twisting of the column at the seat of curvature, and not of rotation of the individual vertebræ upon their axes.

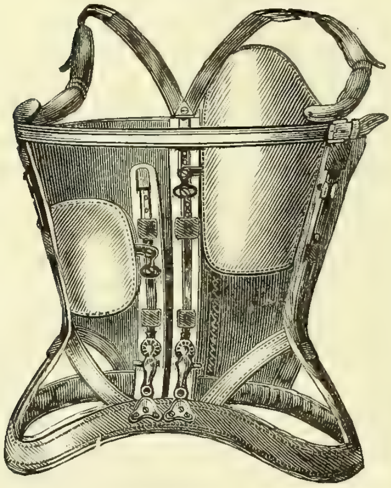
Treatment of Lateral Curvature.—The various methods which have been employed to restore the scoliosed spine to its normal shape, may be classified in two divisions—the physiological and the mechanical. The former of these consists chiefly in the use of different exercises, so designed as to bring into action the muscles of the trunk on the concave side of the curve, and thus to draw the spine towards the mesial line; a mode of treatment which is adopted by those who consider that irregular muscular action is the producing cause of the deformity. Mechanical treatment has been applied in many ways, all of which are modifications of one of two different plans for bringing mechanical force to act upon the column in order to reduce the deformity. Of these two mechanical methods, one consists in the application of pressure whilst the subject is in the horizontal position, a couch with adjustable levers and movable pads being the instrument usually employed; the other method requires the use of an appliance fixed to the body, and so constructed as to admit of pressure being brought to bear upon the spine at the seats of curvature. The above measures of treatment have each their separate advocates, each plan has received enthusiastic support as well as severe condemnation, and here again the want of unanimity may be ascribed to an absence of agreement amongst authorities upon what does and what does not constitute lateral curvature; thus, it is not uncommon to find a case of lateral bending of the spine, which has been successfully relieved by a certain mode of treatment, described as one of lateral curvature—a mistake which is naturally productive of confusion in any discussion which may ensue as to the value of the measures of treatment employed. In endeavoring to decide upon the best plan to adopt for the reduction of lateral deviation of the spinal column, it is of the first importance that the varying conditions of deflection should be clearly distinguished one from another; that condition which has been described in this article as *lateral curvature* being the most grave condition of deformity, its treatment may well claim priority of consideration.

The opinion is very generally held that all attempts to reduce the distortion in a scoliosed spine are pretty sure to be attended by failure; undoubtedly, when the distortion has existed for some years and has reached a severe grade of deformity, the restoration of the spine to its normal condition is not possible by any methods of treatment with which we are at present acquainted; it is also true that this advanced stage of deformity is very commonly met with, so that at first sight it might appear as though the relief of lateral curvature was in all its stages not attainable. There are many causes, however, which contribute to the development of lateral curvature, and to its advance to an incurable stage—causes which are beyond the control of the surgeon; the chief of these is the neglect often exhibited by the patient or her parents, to seek advice whilst the deformity is yet in its early stage. Unattended by any general failing of the health, as is so frequently the case, the first evidences of commencing curvature are disregarded; and the prominent shoulder, or hollow flank, is looked upon as merely one of those bodily defects which will disappear with advancing age, and that mysterious power which consists in "growing out" of the defects, is trusted to put all straight with time. Even if the above mistake is avoided, and advice is sought for at the right time, it is not uncommon to find those who are especially interested in the well-doing of the patient, quite incapable of appreciating the absolute necessity which exists for carefully following out the methods of treatment which are ordered; they fail to understand that so apparently slight a condition of bodily change may lead to a state of most sad deformity, and the instructions for the management of the case are so simple in their nature that they lack that attribute of impressiveness which is so necessary to the uneducated mind. In the treatment of lateral curvature, the means selected must vary according to the nature and condition of the displacement; with reference to this point, authorities usually describe the deformity as passing through three stages, a first stage of incipient or commencing curvature, a second stage of established curvature, and a third stage of confirmed or incurable curvature. The distinction between the first and second stages is often made by defining the latter as that period at which rotation of the vertebræ occurs; this is an error which has arisen from an inability to distinguish between the different forms of lateral deflection, the so-called first stage of lateral curvature being in fact merely lateral bending of the spine, for, as has already been described in this article, lateral curvature from its first commencement is accompanied by rotation of the vertebræ, the displacement of the bodies of the vertebræ always preceding the deviation of the spinous processes. The stage of curvature is by no means the chief point which is to be considered; of far more importance are the nature and position of the curves formed in the spine, with reference to which the nature of the treatment must be adapted to meet the peculiarities of each particular case.

With regard to the commencing stage of lateral curvature, there are certain general rules which are applicable to all cases. The departure from the normal condition of the spine which has to be dealt with at this period, consists in the deviation to one or other side of the bodies of a certain number of the vertebræ: if the dorsal region be affected, there will be some prominence of the scapula on the side to which the bodies are turned, with perhaps a little elevation of the shoulder; in the lumbar region, there will be slight fulness of the muscles on one side of the spine, with a depression at the corresponding spot on the other side; and together with these external evidences of curvature, there will be compression of the intervertebral disks on the concave sides of the curves. There may be present with the local defect some interference with the general health, the most frequent fault being irregularity of the menstrual function; when this or any other form of malady exists, it must of course receive attention. As to the condition of the spine, the chief points to be gained are restoration of the normal state of the intervertebral disks and replacement to the straight line of the bodies of the vertebræ; to meet these indications, the following course of treatment is generally applicable. The spine should be douched daily with cold water, and afterwards be well rubbed with a rough towel, and shampooed for about ten minutes with the hand; local circulation is thus stimulated, and nutrition is promoted. Standing about, or sitting on a stool or chair with a straight back, should be strictly prohibited (in either of these positions, leaning to one side or the other is certain to occur), and a chair with the back sloping to about half a right angle with the seat should always be used. All employments or games in which one arm is used more than the other must be interdicted, but a moderate indulgence in such pursuits as equally give exercise to the two sides of the body is to be recommended; rowing, or rather sculling, is an excellent although perhaps somewhat mannish exercise, and swimming also is beneficial. Walking is the most desirable of all exercises, but nothing must be done which produces fatigue, and the recumbent position should always be assumed for about an hour after exercise. Such accomplishments as piano-playing need not be altogether given up, but these practices must be followed early in the morning when the spine has been strengthened by the night's rest. In this early stage of deformity, it is generally considered that mechanical support of the spine is not required, but as to this point no universal rule should be followed: when the curves present are not of any great length, a mechanical appliance is not necessary, but when several consecutive vertebræ are displaced, it is advisable to order a light corset stiffened with small steel bands, which gives some support to the spine and limits lateral movement of the column. The general directions given thus far are intended to fulfil the following purposes: to permit of sufficient use of the spine to keep it in healthy action; to check unequal compression of the intervertebral bodies; and lastly to allow those bodies which are deficiently elastic the opportunity of gradually recovering their normal state of expansion. The commencing stage of lateral curvature is not unfrequently treated by complete recumbency; no doubt, constant lying on the back relieves the intervertebral disks from all risk of compression, but I believe that a limited use of any part, which is not affected with inflammatory action but merely in a condition of atonic degeneration, is most beneficial to the disordered tissues. It is sufficiently familiar to all surgeons that disuse is accompanied by wasting; to leave the intervertebral disks in a state of sluggish repose, is not calculated to induce the restoration of their natural elasticity. A contrary method of treatment is the employment of free extension of the spine, either by causing the subject to swing on a trapeze, or by some other method of suspension: this procedure is unadvisable, as it produces too great stretching of the fibrous tissue; and it is not better contrived to restore the elasticity of the intervertebral bodies, than would be constant expansion to renew that of a weakened spring.

When lateral curvature is not arrested by the above measures, or when it is presented for treatment in a more advanced condition than that just considered, it is necessary to employ some form of mechanical treatment. The most convenient method of using instrumental treatment is by means of an appliance fixed to the body, which shall exert a constant pressure upon the displaced vertebræ, and prevent them from becoming more removed from the mesial line. Very many different kinds of spinal support have been invented for this purpose, but to describe these would occupy too much space, and I shall only allude to those which practical experience has shown to be efficient in obtaining the desired result. The qualities required in a spinal support are the maximum of strength with the minimum of weight; rigidity is of all things essential, and the difficulty is to obtain this without making the instrument so heavy that it is an incumbrance rather than a support to the patient. It is also necessary that the appliance should be so adjusted as to produce pressure at the seats of curvature, and be capable of readjustment as the deformity becomes lessened. A spinal instrument which shall fulfil the above conditions must consist of two portions—one a rigid framework which can be firmly attached to the body, and the other of movable parts to exert pressure upon the displaced vertebræ. The instrument illustrated in Fig. 1509 is commonly called the lever support, and is the best form of appliance to use when the surgeon is able to see the patient frequently. The framework of this support consists of a pelvic band which is so curved that it fits accurately to the pelvis (a point which is of great importance), and to which are attached on each side lateral supports terminating in crutches; steel bands, passing over the hips, connect the belt and lateral bars, which they hold firmly together, thus giving rigidity, and at the same time permitting very light steel to be used in their manufacture. A light thoracic and abdominal belt, which laces down the front, completes the framework of the support. The acting part of the instrument consists of levers, to which are attached plates which are carefully fitted to the curved portions of the spine, and which are at the same time made sufficiently large to give lateral support to the body. In the condition of curvature usually met with, that of a dorsal curve to the right side and a lumbar curve to the left, the upper plate is attached to the right side and made long enough to extend over the whole length of the curve, and broad enough to cover the posterior surfaces of the corresponding ribs; the lower plate is fixed to the left lever, and is so fitted as to press upon the displaced lumbar vertebræ. The levers to which the plates are attached are supplied with rack and pinion movements, by which the plates can be moved in a forward direction, or laterally, as may be required. In using the lever instrument, care must be taken not to exert too much force, but merely to make firm pressure with the plates upon the displaced vertebræ; a common error in fitting this appliance consists in making the side crutches too long, for the purpose of pushing up the shoulders and thus endeavoring to produce extension of the spine. Of course, no amount of elevation of the shoulders will have any effect upon the spinal column, and the only use of the crutches is to afford lateral support to the instrument, and to give counter-resistance in front to the pressure of the lever plates.

Fig. 1509.



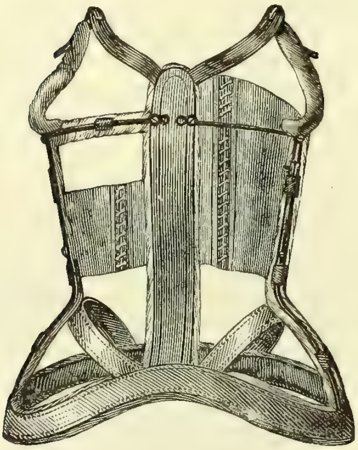
Spinal support with levers and plates.

Spinal couches, which have been already referred to as one form of the mechanical appliances used in the treatment of lateral curvature, are not much employed in the present day. The principle upon which they act is by no means a bad one, and in a few cases I have employed a method of somewhat the same nature, and with some measure of success. The patient lies in the prone position upon a firm mattress; the pelvis is fixed by a belt which is itself attached by means of cords to rings fitted to the floor, or to heavy weights, so as to steady the body. The arms are fully extended, and a rod is grasped with the hands in such a manner that the patient can exercise a slight amount of self-extension of the spinal column. Upon the seats of curvature, bags of shot are laid along the sides of convexity, the weight being regulated by the feelings of the patient, and just such an amount of shot being used as can be borne with perfect comfort. By this method the vertebræ are pressed forward into position whilst the spine is slightly extended, and thus in a simple manner is obtained the action of the cumbrous spinal couch with its formidable-looking levers and extension-racks.

The most effectual method of acting upon the displaced vertebræ is by manipulation; this treatment, employed many years ago, has been almost entirely discontinued, yet to its use we are indebted for the first discovery of the fact that lateral curvature of the spine is something more than a mere lateral deflection of the column, for Dr. Dodds, in using manipulation, found that the vertebræ were twisted as well as displaced to one side. The use of manipulation, and the advantage thereby gained in the treatment of various other conditions of distortion, have been frequently described in this article; and the same agent, in my opinion, is of equal value in the treatment of lateral curvature, for no mechanical appliance can act with the same precision, and give such well-directed pressure, as the hand. The patient may lie in the same position as that described for the employment of weights during slight extension; instead of acting upon the displaced vertebræ with bags of shot, an attendant steadily presses with the hand upon the convex side of the curve. The upper and the lower curves are worked at simultaneously, a hand being placed on each, commencing at the lowest vertebra and gradually going upwards through the curves, and continuing the exercise for about half an hour. The employment of manipulation, with the application of the lever spinal support, and the observance of the general rules laid down for the treatment of the early stage of curvature, constitute the most efficient plan to adopt for the relief of curvature existing in the conditions illustrated in Figs. 1502, 1504, and 1505; modifications in the treatment are required according to the seat and length of the curves. When there is either a long upper or a long lower curve, the precautions as to rest, etc., must be most strictly adhered to, for the greater the number of vertebræ consecutively involved in a curve, the greater is the risk of increase of the deformity, and the more necessity there is for relieving the spine from unequal compression.

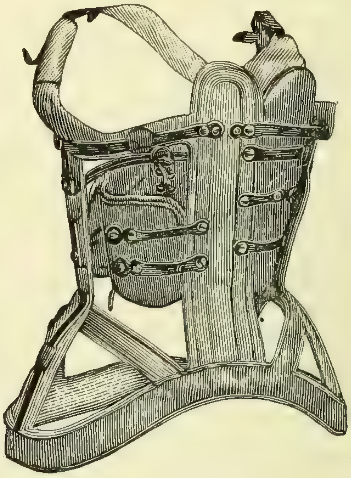
In the more advanced conditions of lateral curvature, reduction of the deformity can never be completely obtained, but usually a considerable amount of improvement can be effected by the use of mechanical appliances. The most suitable instrument to be used in such cases is that illustrated in Fig. 1510; this support consists of a framework somewhat similar to that of the lever instrument already described, the pubic belt and arm-crutches, with the hip-pieces, being the same in each appliance. Instead of the movable levers, a central bar of steel is carried up the back, being connected to the arm-crutches by two bands of steel passing across the scapulæ. The acting portion of the appliance is found in two shields of strong jean, which can be tightened by means of a lace; these shields are attached to the side crutches and the central bar, and can be made to produce any degree of pressure upon the thorax and spine by lacing them up to the required tightness. From the strength of its framework, and from the ease with which it is adjusted to suit the requirements of the case, this instrument is a most suitable one to employ in the treatment of old established curvature, and in those cases in which the patient is unable to attend for frequent adjustments by the surgeon. Another instrument which is to a considerable extent self-adjustable, is that introduced by Mr. Wm. Adams (Fig. 1511).

Fig. 1510.



Spinal support with shields.

Fig. 1511.



Spinal support with spring-plates.

It consists of a framework similar to that of the laced-shield support, but the shields are replaced by plates which are fitted in accordance with the condition of curvature, and which are kept in a state of constant pressure by means of springs connecting the plates with the central bar. This support is of great value both in the early stage of deformity, where there is a long curve, and also in long-standing cases in which the curvature is not very severe, but has become confirmed from the lengthened period of its existence.

The mechanical appliances above described are those which I am in the habit of employing; many other forms of support have been invented, but not having had any practical experience of their action, I cannot offer any opinion as to their value. The surgeon, in selecting an instrument, must see that it consists of a rigid framework with adjustable actions to give pressure at the exact spot required.

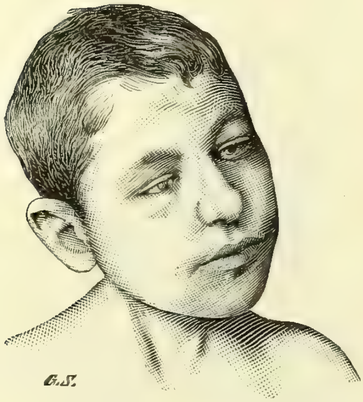
One method of treating lateral curvature that has been employed of late years, must be noticed on account of its very general adoption by those who have not had much experience in the treatment of this deformity. This method is that introduced by Dr. Sayre, and it consists in the application to the body of a plaster-of-Paris jacket, and in the daily use of self-suspension. The jacket is made by incasing the body in plaster-of-Paris bandages, whilst the patient is suspended by the head and arms. Daily suspension is also ordered as an exercise to gradually reduce the curves by stretching. Dr. Sayre argues that, by applying the jacket during extension, the stretching of the spine then obtained is permanently maintained; and in support of this theory he quotes cases in which the height of the patient was considerably increased after the application of the jacket. But it is evident that if the plaster-of-Paris jacket is a perfectly retentive splint, as Dr. Sayre declares it to be, self-suspension after the jacket is applied can produce no result, since the spine is already rendered inextensible by the fixing support; on the other hand, if extension of the column can be obtained, then the jacket is an insufficient support, because any reduction of the curvature which results from the daily exercise is not maintained, for the spine must sink back to that condition in which it was when the jacket was applied. All forms of jacket which incase the body are unsuitable appliances to use in the treatment of lateral curvature, because they prevent the employment of those physiological measures which have already been described; valuable as the jackets may be in the treatment of caries of the vertebræ, when the one object of treatment is to fix the spine, their use in the reduction of lateral curvature is distinctly contra-indicated, for in this affection the object to be gained is not fixation of the column, but its restoration to the normal condition.

The treatment of lateral deflection of the spine resulting from simple *bending*, is best conducted by the use of exercises which strengthen the muscles of the back, and by attention to the general health. Mechanical appliances should if possible be avoided, but in cases such as that illustrated in Fig. 1506, an instrument with laced shields will give the necessary amount of support. Lateral bending combined with lateral curvature, as in the case shown in Fig 1508, should always be treated as one of lateral curvature only, since the improvement of the curvature will be accompanied by increasing strength of the muscles, whilst if the muscular weakness alone receive attention, the displacement of the vertebræ, the most serious part of the condition, will be liable to advance. The case in question (Fig. 1508) was treated on this principle, and resulted in complete recovery; the patient, when first affected with lateral curvature, had been treated with the plaster-of-Paris jacket, the retentive qualities of which appliance had induced muscular wasting, and had superadded lateral bending to the already existing lateral curvature. The possibility of this result from using the jacket is another reason for objecting to its employment in cases of lateral curvature; the case above quoted is by no means one of uncommon occurrence, several similar instances having come under my observation.

WRY-NECK, OR TORTICOLLIS.

Wry-neck results from contraction of the muscles on one side of the neck, the contraction being generally spasmodic in its nature, and either of congenital origin or developed in early infancy. The sterno-mastoid muscle is usually the most affected, but the scaleni and deeper muscles of the neck may also be implicated; in some few cases the latter muscles are the chief cause of the deformity. In the usual condition of wry-neck the chin is raised and directed towards the shoulder opposite to that of the contracted muscles, the head being so turned that the lobe of the ear on the side of contraction is brought forwards and downwards, whilst that on the other side is turned backwards and upwards, the distance between the two ears and the centre of the sternum showing a considerable difference on measurement. The usual position of the head in this deformity is illustrated in Fig. 1512. When the muscular contraction is allowed to remain unrelieved, the features become implicated in the deformity as age advances. This complication results from acquired contraction of the platysma muscle and the muscles of the face; the corner of the mouth is drawn downwards, the cheek is flattened, the lower lid is depressed, and the eyebrow is on a lower level than that of the opposite side. The occurrence of this distortion of the face necessitates the early removal of the contraction of the muscles of the neck, since the distortion of the face, when once acquired, can never be completely removed. The most effectual method of overcoming wry-neck dependent upon shortening of the sterno-mastoid muscles, is the employment of tenotomy. The operation may, in the majority of cases, be limited to section of the sternal attachment of the muscle; in dividing this, the tenotome is entered at the inner border of the tendon and carefully passed behind it, care being taken not to push the point of the knife too deeply; the edge of the knife is turned when all the tissue which requires division is embraced by it, and the section is completed with a few strokes of the blade. When the whole of the muscle requires division, the clavicular attachment is reached by a second puncture made at the outer side of the tendon. This little operation is not unfrequently regarded as a rather formidable one, on account of the proximity to the tendon of the large veins of the neck; in its contracted condition, however, the tendon is in such bold relief that there need be no fear of wounding the vessels, if the precaution be taken of keeping the blade of the knife close to the surface of the part to be cut; to remove the risk of wounding a vein, a blunt-pointed knife may also be used in making the section, as is done when dividing the tendon of the tibialis posticus. The wound is treated in the manner usual after tenotomy, the head being kept steady by fixing it with bandages to the shoulders; it is as well also to keep the patient in bed until the fourth day. After the wounds are healed, mechanical treatment must be commenced; in slight cases, a leather collar may be worn to support the head and keep the muscles extended, but in cases of greater severity, especially in those in which there is much contraction of the deeper muscles, a more powerful form of appliance is required. The most suitable instrument consists of a framework somewhat similar to the laced-shield spinal support; to the back lever of this instrument is attached a neck-piece with three racks and pinions, one giving lateral, another rotatory, and the third flexion-and-extension movements. A plate against which the occiput rests, is attached to the neck-piece, and to this plate are fixed two levers provided with movable pads; one of these levers fixes the head by pressing against the side of the frontal bone on the side of the contracted muscles, while the second is carried forward to the lower jaw, where the plate rests a little behind the chin on the side opposite to that of contraction; these levers are supplied with racks, which enable the head to be very perfectly carried into such a position as shall produce full extension of the shortened muscles.

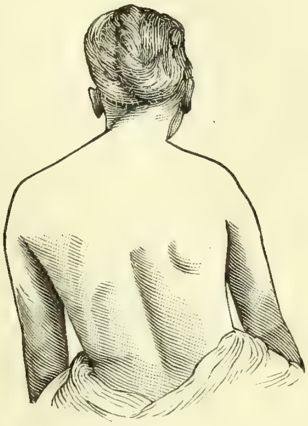
Fig. 1512.



Wry-neck.

A severe complication of wry-neck which has existed for many years, is the formation of lateral curvature. Deformity of the spine resulting from this cause is illustrated in Fig. 1513. Three curves are generally formed, one in the cervical, a second in the dorsal, and a third in the lumbar region; rotation is not present in the early condition of this curvature, but it becomes established as age advances. If not of long standing, the curvature of the spine is remedied by relieving the muscular contraction, but when the deformity has been allowed to continue unchecked until the adult age, the condition is very difficult to overcome. The use of a spinal support for many years, will, however, gradually improve, if not altogether reduce, the curvature, the contracted muscle having been of course first treated. The best form of instrument is that with spring-plates, recommended for the treatment of lateral curvature; one of these plates may be attached to the top of the central lever, and carried up so as to give support to the cervical vertebræ.

Fig. 1513.



Curvature of spine from wry-neck;

A condition of wry-neck is very frequently met with after scarlet fever, rheumatism, and other acute attacks of disease. This condition generally depends upon contraction of the deep muscles of the neck rather than upon shortening of the sterno-mastoid. Tenotomy is not admissible in the treatment of such cases, but they yield very readily to instrumental measures. The chief interest attached to these cases is the somewhat close resemblance which they bear to the early stage of cervical caries, for at the commencement of the latter disease the head is very frequently carried to one or other side. The absence of local pain, and still more the perfect freedom of movement between the separate vertebræ, when the neck is flexed and extended, will generally suffice to establish the exact nature of the case, for we very rarely find caries of the vertebræ accompanied by free movement of the affected bones. It is as well in all cases of lateral deflection of the head observed after an attack of acute illness, to be somewhat guarded in making a diagnosis; fortunately, a similar course of treatment is applicable to both the conditions referred to, for a few days' rest will generally greatly improve the condition of wry-neck, whilst this treatment can be continued if the more severe affection be found to exist.

[*Wry-neck, with painful, convulsive spasm of the affected muscles*, has been successfully treated by the administration of bromide of potassium and the corrosive chloride of mercury, by Dr. Little; by the application of the hot iron, by Dr. C. K. Mills; by stretching the spinal accessory nerve, by Southam and Mosetig-Moorhof; and by resection of the same nerve, by De Morgan, Annandale, Rivington, and Tillaux.]

[CONGENITAL DISLOCATIONS.

A few words may be said here in regard to the condition known as *congenital dislocation*, an affection most often met with in the hip, and very generally confounded with hip-disease. This subject has been particularly illustrated in the writings of Dupuytren, Carnochan, and Holmes, and more recently in excellent articles by Prof. Bennett, of Dublin, Dr. Buckminster Brown, of Boston, and Mr. William Adams, of London. Three theories have been advanced to account for the occurrence of the so-called congenital dislocation of the hip, viz., (1) that it is a true traumatic dislocation, resulting from injury inflicted before birth or during delivery; (2) that it is a deformity caused by spasmodic muscular contractions during fœtal life, and analogous to club-foot; and (3) that it is due to a malformation of the acetabulum, with consequent displacement of the head of the femur owing to the deficiency of the socket in which it is normally held.

With regard to the first theory, it may be said that, though it is not denied that the femur or any other bone may be dislocated during delivery, yet, as a matter of fact, in most cases of congenital dislocation the labor has been a natural and easy one, and no pain or deformity has given rise to the suspicion that such an injury has been inflicted until long afterwards, not indeed usually until the child begins to walk. To the theory of spasmodic muscular action, of which the chief advocate has been M. Guérin, it may be objected that the affected joint is not found spasmodically contracted or fixed, either at the time of birth or subsequently, but that it continues freely movable in all directions—sometimes abnormally so—and that there is commonly no difficulty, even in inveterate cases, in restoring the head of the bone to its proper place, though it cannot be kept there. The third theory, that of original malformation, was entertained by Dupuytren sixty years ago, and is that which has secured the adhesion of most writers on the subject; it is indeed the only theory that satisfactorily explains the symptoms and course of the affection.

Congenital dislocation—the name, though not strictly correct, may be retained from motives of convenience—may affect one or both hips. As already mentioned, it is usually not observed until the child begins to walk, when, if one side only is involved, lameness without pain is noticed, and on measurement the affected limb is found slightly shorter than the other; as the child grows older, obliquity of the pelvis and compensatory lateral curvature of the spine follow. In double dislocation, the deformity is very striking and characteristic; the hips seem widened, and the trunk as it were sinks in between them; at the same time the pelvis is markedly tilted forward, the sacro-lumbar vertebræ becoming almost horizontal, with extreme lordosis and prominence of the belly, and the patient walks with a peculiar rolling or waddling gait which is of itself almost diagnostic.

The *treatment* of congenital dislocation of the hip is usually unsatisfactory. The limb can without much difficulty be pulled into position, but the defective acetabulum will not retain the head of the bone, and it slips out again as soon as the part is left to itself. That a cure is possible, is shown by a remarkable case reported by Dr. Buckminster Brown, of Boston, in which, by the adaptation of ingenious mechanical apparatus, the head of the femur was kept in its proper place until by pressure it had effected so much deepening of the acetabulum that there was no longer any tendency for it to escape. The treatment extended over more than a year, and though the result was a complete success, it could not have been so but for the fortunate combination of a patient much more reasonable and enduring than most children, parents unusually intelligent and persevering in carrying out instructions, and a surgeon who, with large experience in orthopædics and great ingenuity in the adaptation of apparatus, was both able and willing to give the case unremitting personal attention.

In most cases, if the malformation affects only one side, it will be sufficient to direct the wearing of a high-soled shoe, so as to equalize the length of the limbs and prevent the development of lateral spinal curvature which would otherwise be inevitable. Mr. Adams advises that the patient should be made to lie down for at least half the day during all the period of active growth, and that he should practice suitable gymnastic exercises in the recumbent posture. In double dislocation, attempts have been made to prevent displacement by the application of a leather girdle or other compressing and restraining apparatus, but the remedy is irksome and inefficient. Tenotomy has been practised in these cases, by Guérin, Brodhurst, and others, but I confess that I do not see on what grounds; certainly in the examples of the affection which have come under my own observation, tenotomy could have been of no service. Excision of the hip is another operation which I cannot recommend in the treatment of congenital dislocation, although it has been adopted, and with alleged benefit, by Rose, Reyher, Heusner, Margary, and perhaps other surgeons.]

APPENDIX.

CONSTRUCTION AND ORGANIZATION OF HOSPITALS.

BY

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History of Hospitals.

In considering the general question of hospital construction and organization, the history of the subject is of great interest, as showing the gradual evolution of the principles accepted at the present time. From the earliest recorded accounts of humane provision for the sick and suffering, through periods of advancement and retrogression, we may find from time to time the germs, and trace the growth, of present ideas, which have been formulated only within a comparatively few years into the system of construction now accepted.

The first hospitals on record are said to have been established by Buddhist priests in Hindostan, two or three centuries before Christ. These disappeared with the restoration of the Brahminical religion, and such hospitals were not again seen in India until the advent of the British. There are only scattered and uncertain notices of hospitals for the sick in Asiatic, Greek, and Roman history. The many temples of Æsculapius that existed for several centuries before the Christian era, were resorted to for miraculous interference against the anger of some supernatural power which the ancients universally believed to be the cause of all disease. Recent archæological discoveries have revealed records of such cures in the temple at Epidaurus, as early as the end of the fifth century B. C., about which time conflicting opinions on science and religion arose among the Greek philosophers. The Roman *hospitium* was a place for the reception and shelter of strangers, rich or poor, and for a long time there were few establishments for invalids; but in the fourth century hospitals were commonly known, and in the ninth century there were twenty-four in Rome alone. There are some earlier suggestions of the principle of military hospitals, in the provision made by some of the great Roman generals for the removal of the sick and wounded from camp to the nearest towns before a battle; and by having chariots follow the army on the march for conveying the wounded, the modern ambulance was anticipated. The first actual attempt at the establishment of military hospitals may be assigned to the time of the Crusades.

The first hospital for the insane, on record, was established at Jerusalem,

A. D. 491, and at a later period such hospitals were established by the Saracens. The first institution for clinical instruction was probably that connected with the celebrated medical school at Edessa, in Mesopotamia, founded in the fifth century by the Nestorians, who went there to escape the persecutions of the church at Rome, and were afterward scattered into Persia and Arabia. From them, and from the Athenian philosophers exiled by Justinian, the Arabs received the first elements of a science which they afterwards restored; and they, in Spain, first established hospitals like our modern institutions, in the eighth and ninth centuries, notably the one at Cordova with its famous school of medicine.

The real origin of our present hospitals is to be found in the monastic establishments of the Middle Ages, each of which had its infirmary, which afterwards was placed in a separate building constructed for the purpose. The Hôtel Dieu, in Paris, dates from the beginning of the ninth century. In England, the earliest distinct record is of two hospitals founded in 1080, by the Archbishop of Canterbury, and during the next two centuries some of the most noted establishments for the sick in England were established. Great abuses grew up in the monastic institutions: they were converted into benefices by the clergy, benefactions were misapplied, the welfare of the sick became of secondary importance, and the hospitals were badly managed and terribly unhealthy. It was not till after the Reformation that the way was opened for the founding of private and public charities for the sole benefit of the sick poor, and it was nearly two hundred years later, and after the beginning of the eighteenth century, that hospital construction received the great impetus which has developed the present system of treating the sick in such institutions. Many noted hospitals were built in England in that century, and the movement spread to the rest of Europe. The influence of the monastic age still held sway in the forms of these buildings, which were usually large, many storied, and badly arranged; and the sick were aggregated in them in a most unhealthful way.

In America, a strict quarantine was established in Boston Harbor as early as 1647, against "y^e plague or like infectious disease" then raging in the West India Islands, and in 1717 a quarantine hospital was built, and has been maintained ever since on some one of the islands of the harbor, sometimes being used for infectious diseases. Epidemics of smallpox were very disastrous in the colonies. Variolous inoculation was introduced into America in 1721, in Boston, and the first public hospitals for smallpox were established there in 1764, in military barracks or like buildings constructed for the purpose. Soon after this it became the custom throughout the colonies to appoint secluded houses as temporary pest-houses for inoculating and treating the disease. The first hospital on Manhattan Island was built by the Dutch, early in the seventeenth century, with a capacity "of five houses;" but the first of the existing general hospitals founded in America, was the Pennsylvania Hospital, founded in 1751, though its new building, a part of the present hospital, was not opened till 1756. The insane were also treated there until a special department was built for the purpose in West Philadelphia, in 1841, and its massive linear plan of corridor wards became, with some modifications, the model for many large hospitals for the insane, in all parts of the country, built previous to 1880. The New York Hospital, chartered by George III. in 1771, was burned as soon as completed, and after being rebuilt received its first patients in 1791. The insane were also treated in the original building here, until 1808, when an annex, called the "Lunatic Asylum," was added, the first establishment in the United States wholly for the care of the insane, except the one at Williamsburg, Va., opened in 1773, which was the very earliest. The department for the insane at Bloomingdale was not opened till 1821. The Friends' Asylum, at Frankford, Pa., opened in 1817, was the second institution in the country founded solely for the insane.

The Revolutionary war greatly stimulated the progress of medical science, and military hospitals were established in various parts of the country, particularly in Pennsylvania, New Jersey, New York, and Boston; but at the beginning of the present century there was no hospital for the treatment of general diseases in Massachusetts. The first U. S. Marine Hospital was built in Charlestown in 1803, and the Massachusetts General Hospital, the third of the important institutions of the kind in the country, was opened in 1821, its department for the insane, McLean Asylum, having received its first patient in 1818. In 1840 there were about fifteen hospitals for the insane in the United States, and in 1880 there were 137 such establishments, public and private.

The permanent hospitals built before the middle of the present century in this country were upon the block or corridor plans, and the Hospital of the Protestant Episcopal Church in Philadelphia, and the Boston City Hospital, opened in 1862 and 1864 respectively, only about ten years later than the first foreign hospital of the kind, were the first permanent ones in America having detached pavilions connected by open corridors.

M. Tenon is credited with first having treated the subject of hospital construction scientifically, in his memoirs presented to the Academy of Science in 1787, in relation to the hospitals of Paris, and particularly to the terrible condition and frightful mortality of the old Hôtel Dieu. He not only laid the foundation of the present system, by advocating the use of one-story pavilions, but he uttered the soundest doctrines in regard to proper organization and management. Again, however, the opposition of non-medical influences, and political events, arrested progress, and it is curious to notice that the first pavilion hospital, the Lariboisière, was not completed until 1854, and that it was three-storied, and had such grave defects of construction as to make it a failure. It marks, however, the beginning of the present era of pavilion hospitals and of hospital reform, to which the largest contributions have been made by the experiences of the great wars of the last thirty years. The practical advantages of simplicity of construction were thereby forcibly shown, as well as the value of segregation of the sick, the need of cleanliness in hospitals, and the importance of their intelligent management; and with these requisites gained, some extreme views have since become modified, so as to admit of permanency with simplicity.

CONSTRUCTION AND ORGANIZATION OF HOSPITALS.

Some general considerations naturally present themselves at the outset, when we come to the construction of the hospital building. The general hospital is typical of all, in its embodiment of general principles. The whole subject will be treated of here in the order of the procedures that practically would be pursued, were the task of building a hospital actually in hand:—

1. General considerations, including the subject of unhealthiness of hospitals, and the means of avoiding it.
2. Location, site, and area.
3. Material and foundations of wards.
4. Form and construction of wards.
5. Size of the hospital, and arrangement of wards and accessory buildings.
6. Warming, ventilating, and lighting.

7. Furnishing.
8. Organization and management.
9. Nursing.
10. Special hospitals.
11. Cottage and convalescent hospitals.

General Considerations as to Hospitals.—Before selecting the site of a hospital, certain principles must be adopted which will govern the details of the whole scheme, as to the form, size, and arrangement of the buildings. A general idea must be had of these essential principles in order to determine the location, area, and aspect of the site, with relation to the hospital itself and its surroundings. It may be assumed that there will be an administration-building centrally placed, with buildings for wards, kitchen, and laundry, and other service-buildings, conveniently grouped, and if possible a separate house for nurses. The number and purposes of these buildings should be decided upon, with provision for future enlargement of the hospital. When, as is usually the case, only a part of the desired hospital is to be built at first, the whole scheme should be well considered, and everything done with relation to that, so as to make the expense of altering and enlarging the buildings as small as possible.

The pavilion system should be adopted, and the question of having buildings of one, two, or three stories, and how many of each, must be settled at the outset. Three-story pavilions should be objected to, except possibly for a limited and special class of cases; and then, in dealing with committees and architects, there will arise questions as to the desired capacity of the hospital, and the material and cost of the site, in relation to the available funds. The area of the site may be roughly estimated at one acre for each eighty or one hundred patients, but the number will depend somewhat upon the arrangement of the buildings.

The idea of erecting temporary structures, to be torn down in ten or fifteen years, where there is designed to be a permanent hospital, may be set down at once as impracticable. As an illustration of this, two one-story square wards of the Massachusetts General Hospital, "designed for temporary structures, to be taken down and rebuilt after ten or twelve years' service," were repaired in 1884, after ten years' use, by building new and permanent foundations under them, because "they had proved to be more durable than was expected, and had retained their original high sanitary condition." At the Boston City Hospital there are two wooden, one-story pavilions, covered with corrugated iron, built as temporary structures in 1876. They have an ample and expensive arrangement of steam-heating coils, which are quite necessary, because it was shown by actual measurement, in 1878, that in cold weather not only was the air-supply per bed, from the inlet-registers, 8000 feet per hour, but that 2000 feet more per bed of cold air entered through the cracks, etc., in the walls, to be warmed and conveyed away through the ventilators. Practically such buildings are expensive to keep warm, too costly to be destroyed after a few years' use, and not likely to be replaced; but their defects and discomforts will appear sooner or later, increase with their age, and endure until they are worn out. Permanent buildings of lasting materials, stone and brick, and modest in architecture, are the best, and can be made as healthy as any. They are much more comfortable and satisfactory, and require less repairing. Means of warming and ventilating can be adapted to them better, and more economically in the long run, in the latitudes of cold winters. Farther south, they are the coolest in summer, and a more equable temperature in winter can be kept in them than in wooden buildings. There should be a few destructible wooden huts for certain cases, and ground space for tents for summer use, while the permanent wards are being renovated; but it may be put down as essential that there should be pavilions of moderate size, of permanent material, and of one, two, or three stories, according to their purposes, with sufficient space, per bed, in the wards, and between the buildings; and that the question of capacity should be subordinate to these requirements. Wooden structures may be used, of course, for temporary and special purposes.

The general principles thus briefly stated as essential, are so far accepted at the present day, as to practically form the basis of all recent hospital construction. They are the results of much trial and cost of life and money, and the processes through which the best ideas have survived, have been long and toilsome, as the history of the subject shows. These axioms have been formulated from experience gained in advance of the more scientific investigations of the cause of the evils that have beset establishments for the care of the sick. These evils may be now considered as the things to be avoided, and as furnishing reasons for the accepted dicta of hospital construction.

The sole purpose of the hospital is to treat the sick and wounded, and nothing should be admitted into it or its construction to conflict with that purpose. It should be a healthy hospital. A reasonable amount of architectural grace and adornment may be allowed, inside and outside, to satisfy the æsthetic sense of those who build or endow public or private hospitals, and in some degree such ornamentation will be good for the sick also; but this should not be allowed to impair in any way the healthfulness of the building. Mr. Simon has defined a healthy hospital to be "a hospital which does not, by any fault of its own, aggravate ever so little the recovery of the persons who are properly its inmates; . . . . and the fault of its own, through which an unhealthy hospital fails to attain the best results for its medical and surgical treatment, is of two kinds—either it is an inherent fault, as of site and construction; or else it is a fault of keeping, as dirtiness, or overcrowding, or neglect of ventilation."

No better statement than that just quoted could be made of the real truth in regard to so-called "hospitalism," which is defined by Mr. Erichsen as a term which means "a general morbid condition of the building, or of its atmosphere, productive of disease." Sir J. Y. Simpson evidently intended, in his original use of this term, to declare that the tendency to the generation of septic diseases in hospitals was in proportion to their size and age, because of the accumulation of danger by the aggregation of the sick and wounded in them.

There are different sources of impurity in a hospital ward. The gases emanating from the lungs and bodies of the patients, and from decomposing excretions, secretions, etc., may be sufficiently diluted with fresh air to prevent injury to health. Certain classes of cases, as of organic, renal, gastric, cardiac, and nervous diseases, rheumatism, etc., may be treated together in large number with little danger of generating septic influences. But the chief danger arising from the aggregation of the sick, is from the cases productive of disease-germs—cases of infectious disease, of inflammations of the mucous membranes, of fever, of unhealthy wounds, etc. From these the germs or particles of poisonous organic matter may be conveyed by uncleanly hands, clothing, instruments, and utensils; or being dried, and becoming what La Roche calls "vehicles of contagion," they lodge and collect in cracks and upon projections, to again resume their atmospheric journeys. These particles, coming in contact with the living body, may generate various morbid processes according to its conditions and the place of contact. Dilution of the air does not lessen their virulence, and disinfectants do not effectually destroy them. Many may be carried away by good ventilation, and this must be supplemented by properly classifying and isolating dangerous cases; by thorough cleanliness, removing at once all septic elements; and by repelling all atmospheric impurities that may come from bad drainage or other external sources.

The investigations and controversies, to which only brief reference can be made here, that have been carried on during the past twenty years as to the nature of these septic influences and the best means of destroying them, have been productive of incalculable good, but they are far from sustaining the conclusions of those who have maintained the theory of "hospitalism." The statistics upon which it is based are found to be unreliable, and not susceptible of comparison. Old and large, and even badly constructed hospitals have been proved to be healthy for surgical cases, when the "fault of keeping" and overcrowding have been remedied, and the ventilation improved. Whether those who believe in "Listerism," or its opponents, are right, it has been proved that cleanliness of wounds and careful dressings, prevent "hospitalism" in well-kept wards, even in large hospitals under disadvantages as to ventilation. The history of maternity hospitals in the last eighteen years proves also the possible immunity from "hospitalism" of puerperal women, in clean wards with sufficient air-space.

Antiseptic surgery may be no less a boon, because of its having brought out the fact that it is not always necessary in hospital wards. The study of the subject has made plainer what we knew before, that there are septic influences in crowded or ill-ventilated wards, that increase the death-rate of medical as well as of surgical cases, other than those that can be destroyed by Listerism.

In considering the causes of "hospitalism," it is interesting to remember that as long ago as 1787, M. Tenon made one of the most important contributions to the subject that it has ever received, when he pointed out the causes of the terrible evils at the Hôtel Dieu. He had learned that wards for cases of putrid fever must not be placed near the wards of the wounded; that the linen and clothing should be separated, according to the locality of the different diseases, so that it should not be taken from one kind of sick person to another. He pointed out the danger resulting from placing from three to six patients in the same bed, and protested against the abuse of putting too many patients in each ward; and he devised a means of comparing one ward with another, by considering the quantity of air which each patient had to respire, and its circulation and removal. He proved that everything essential to the wounded—pure air, cleanliness, and quiet—was wanting at the Hôtel Dieu; he showed that the mortality in puerperal cases was often one-half, and sometimes 19 out of 20; and he proposed to separate such patients from the others —above all, from the wounded; to put a smaller number in the same ward; to ventilate these wards; to shelter them from damp and noise; to separate healthy pregnant women from the unhealthy, etc.; and thus, with a remarkable prevision of what we have seen in our own times, he pictured in strong colors the extreme of the evils which we to-day avoid by the very means he had the wisdom to suggest.

The history of the subject to the present time is but a series of variations in lessening degrees upon this theme, in all the hospitals of the world, which has so slowly come to know the truth. It needs no more proving to show that sufficient room and fresh air, and avoidance of sewage-contamination of water and air, are necessary to prevent either sick or well people from poisoning each other by their neighborhood. Bad construction with good management is still bad; and good construction with bad management may be worse, but can be made altogether good. For our purpose there is only one conclusion: that in building new hospitals we must have good ventilation, pure air, cleanliness, good management, and simplicity of construction, which makes easy all the rest.

Against the theory of "hospitalism," the advocates of which would lead us to build only small, temporary, and destructible pavilion-barracks of one story, we may urge with truth that good work can be done with proper and even better economy, and with greater comfort, in more permanent structures; but this does not prove that it is as well to have all patients in large wards, or that we may return to block buildings, and use five stories as well as one. Granting all that may be claimed for surgical antisepsis by the use of germicides, this by no means lessens the usefulness and the need of simplicity in hospital construction. We must have good ventilation, which is easiest to get in a one-story pavilion, attainable in one of two stories for some classes of patients, but difficult in higher buildings. Experience in managing elevated wards in such buildings, with their inconveniences and dangers, and the difficulties of applying and working in them effective methods of warming and ventilating, and on the other hand the better practical and more easily gained results in one-storied and two-storied pavilions, all teach the same thing. Thus we arrive at the practical conclusions already stated, and can decide upon the proper combination of simplicity and permanency of construction.

LOCATION AND SITE OF HOSPITALS.—There are conflicting indications to be met in choosing the location of a general hospital. Primarily, it is desirable to give it a central and convenient situation for those who will use it the most; and the advantage of ready attendance by medical officers and students, should be considered. But such conveniences must be largely yielded for the sake of healthiness of site, which should be somewhat elevated, and upon dry gravelly or sandy soil, if possible, for good drainage. There should be sufficient space for the buildings to receive unobstructed sunlight, and the prevailing summer winds, which should be free from any insalubrity of marshy lands, impure streams, offensive trades, or collections of unhealthy habitations.

The essential conditions can sometimes be found to a satisfactory degree, in or near the more thickly inhabited portions of the town or city. In this case, if a whole square cannot be set apart for the purpose, there should be a free space on all sides of the hospital, for at least twice the distance of the height of the highest surrounding buildings. Common sense must decide the choice when there are strong reasons for selecting a suburban site. If this be imperative, a small receiving hospital, for the temporary care of the wounded or very sick, may be established at a convenient place within the city. Modern means of easy carriage by ambulance, make this plan more practicable than it was formerly considered. Hospitals for convalescents, incurables, imbeciles, etc., should be placed outside of towns.

As a general rule, according to the Surgical Society of Paris, the hospital should not contain more than eighty patients to the acre of its grounds, or 540 feet to each patient; one hundred to the acre, according to Galton, is the English usage; Tollet proposes a maximum of forty patients to the acre.

MATERIALS AND FOUNDATIONS OF HOSPITALS.—Permanent hospitals, in most localities and climates, should be built of durable materials—brick or stone, or both together. Such buildings may be used a long time, and require little repairing to maintain their comfort, and they are comfortable in all climates and seasons. When economy in first cost is imperative, as in small country or cottage hospitals, well-constructed buildings of wood will do very well. Some very good army post-hospitals, and marine hospitals, of a semi-permanent character, have been built of wood. Large hospitals may well have some small buildings or portable huts of wood, for cases of infectious disease.

Great care should be taken in laying foundations to make them damp-proof, and to intercept the natural flow of ground water that might find its way under the buildings, on the sloping surface of a deep stratum of clay or underlying rocks, and thus cause a constant unhealthy moisture of the cellars. For free ventilation of basements, the buildings may be raised on arches in hot climates, and in colder latitudes there should be abundant window space in the basement walls, to be left open in summer. The basement story should be at least five feet high, and the floor should be made as impervious to moisture as possible, with cement and concrete. It is an objection to have the basements too high, so as to invite the danger of their being used for wards; or too commodious, when, under some stress of municipal economy, they would be liable to be used improperly for storage or other purposes.

The external walls are best made hollow, as such walls may be plastered upon the inside and keep dry without lathing, which makes spaces that harbor dirt and vermin. Impervious wall-surfaces are the best, and as Parian cement is costly and liable to crack, well-painted plaster is more serviceable; it can be washed with soap and water. The plaster can be scraped off and renewed, if the wards become unhealthy. The wards should be ceiled; all corners should be rounded, in the plastering as well as in the wood-work, and there should be as little of the latter as possible. This may be of well-filled ash or oak; plain, varnished pine is much used and very good. The floors should be of narrow strips of hard pine, or other such wood, closely laid with grooved joints. They may be laid on iron beams, with brick arches and concrete to make them fire-proof, and non-conducting as to sound when one ward is placed over another.

Tiles, slate, and marbleized slate, may be used to advantage in water-closets, particularly about the urinals and the partitions between them, and for the floors. In wooden buildings, for warmth in winter, care should be taken to make the outer walls tight by double plastering and careful construction.

FORM AND CONSTRUCTION OF HOSPITAL WARDS.—The unit of construction is the ward. The two chief things to be thought of are: how to get the sick well, and how to do this in the quickest and least expensive way. The number in each ward should be as many as is consistent with efficient nursing. Facility of service is important as regards economy, as well as good service. From 20 to 32 beds are allowable in a ward, according to the character of the cases. Smaller wards increase labor, but a number of rooms for one or two persons are useful for special cases, or for necessary isolation. The oblong ward, with opposite windows on the sides, is the best form for the larger ones, as it gives the greatest economy of bed space. The width should be from 24 to 30 feet, and 28 feet is satisfactory for all open wards. This allows two opposite rows of beds to stand with their heads 18 inches from the walls, for the nurse to pass freely around the bed, and leaves a clear space of 12 feet in the centre of the ward. A linear wall space per bed of 7½ feet gives a floor area of 105 feet per bed, and the length of a ward of 24 beds will be 90 feet. A height of 12 or 14 feet in the centre of a slightly-arched ceiling is ample; and these dimensions will furnish an air-space per bed of 1470 feet. In some good hospitals, in which this average cubic space is largely exceeded, it is by increasing the height above 12 or 14 feet, which is of doubtful utility. With ceiling ventilation at the lower level, the warm foul air escapes sooner from the room instead of occupying the waste space of a higher ward, at the risk of falling and mixing again with the air below; while the same volume of air-supply will more frequently change the whole atmosphere of the room.

This is shown by experiments which were made by myself, with chemical examinations of the air by Dr. Wood, at the Boston City Hospital, and which were published in the Report of the State Board of Health of Massachusetts, in 1879. Commenting upon these experiments, Dr. De Chaumont[1] says that they "show that above 12 feet there is little or no movement in the air, except towards the outlet ventilators; the space above is therefore of little value as ventilation space. Additional height adds also to the cost of construction, increases the expense of warming, makes cleaning more difficult, and to some extent hampers ventilation." A valuable statement of the views of this author may be found in the work of Mouat and Snell.[2]

In surgical and fever wards, the linear wall space may be increased to 8 or 9 feet, as at the Edinburgh Hospital, which will give a floor space of 112 or 126 feet for each bed, and a cubic space of 1568 feet or 1764 feet, respectively. In hospitals of from 50 to 100 beds, the wards may be of from 10 to 16 beds each, for purposes of classification, with care in arrangement to promote economy of service.

The cubic space per bed in such wards should be at least 1500 or 2000 feet, and for separation-rooms 2000 or 3000 feet. Arched ceilings for one story and upper wards are advantageous, if there are ventilating openings in the centre.

In an ordinary pavilion-ward of 24 beds, there may be 7 windows on each side, and thus there will be two beds between each pair of windows and a window between the end beds and the end wall—an excellent arrangement which has been adopted at the Johns Hopkins Hospital. In some surgical wards, with more linear wall-space per bed, a window to each may be allowed.

The windows should have an area equal to 25 or 30 square feet for each bed; this estimate may include the end windows, which should be large, and which it is desirable to have in bays. They should have their sills at 2 or 2½ feet from the floor, and their tops within 1 foot of the ceiling. The upper two feet may be arranged as a transom, with the sash hinged at the bottom and opening inward, and with side pieces of sheet copper, to cover the triangular spaces when open, and to direct the entering air upward to the ceiling. The main portion should have double windows in cold climates, and may be arranged with cords and weights, as on the whole the simplest, and most convenient and manageable plan. Casement windows, with sills at the floor-level, are useful when there are verandas.

In the arrangement of the ward it is better that there should be no service-rooms at the outer end. Dining and examining rooms, small separation-wards, etc., are most conveniently placed at the end at the entrance of the building, and the bath-rooms and water-closets should be near these, with intervening lobbies, leaving the other end of the ward to be made cheerful by pleasant windows with a sunny exposure. In a long ward there is a tendency to the movement of air in the direction of its axis, from the more exposed end, and from any service-rooms that may be there, towards the end which is kept warm by adjoining rooms.

There should be one or two separate rooms, for one or two beds each, attached to each ward; and for service-rooms, a dining-room with food lift, with arrangement for making tea, etc., and for warming food, a scullery or duty room, a small day-room for the head nurse, with water-closet adjoining, rooms for linen and patients' clothing, and a broom-closet. The bath-room and lavatory may open directly upon the service-corridor, for convenience of use, and the bath-tub should be free from the wall on all sides, or except at one end;

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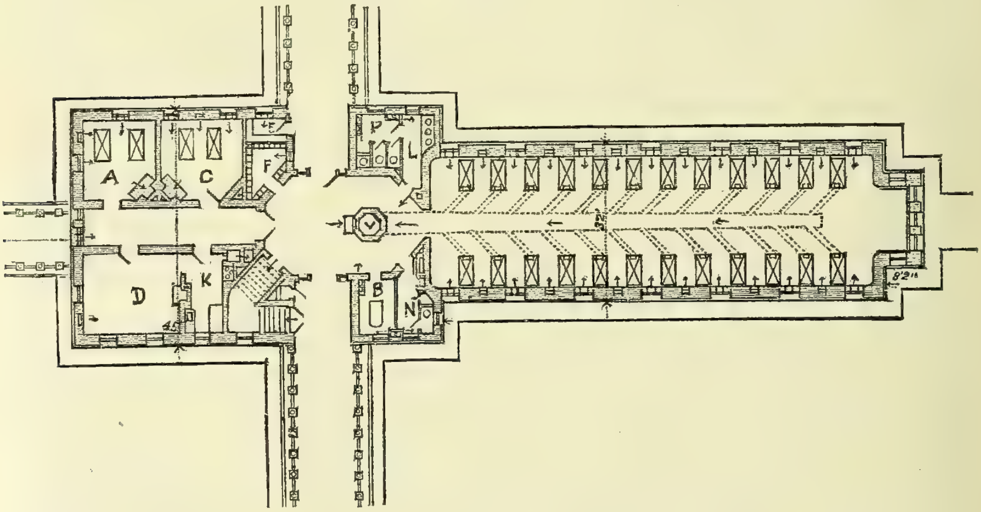
[1] Encyclopædia Britannica, ninth edition. Art. "Hospitals."

[2] Treatise on Hospital Construction, Part ii. p. 50.

but the rule is that the water-closets should be detached, and entered by a lobby with swing-doors and opposite windows. A different arrangement will be seen in the plan (Fig. 1514) of a ward of the Johns Hopkins Hospital, where the lavatory serves as a lobby or intervening room through which is the entrance to the water-closet, the good ventilation of both rooms being considered a sufficient precaution. The advantages of this arrangement are those of convenience and avoidance of a considerable projection from the side of the building, that would obstruct the free flow of air along the outer wall. Three closets, two urinals, and three bowls in the lavatory, are an ample allowance for an ordinary ward for men of from 24 to 32 beds. There should be a special receptacle for chamber-utensils, and the best slop-sink is one which is large and funnel-shaped, of heavy tinned copper, and with a faucet above it, to which a short piece of rubber hose may be attached. This sink should stand free from the wall, on a tiled floor. Simple oval hopper-closets, with flushing rims and hinged seats, are very satisfactory. Automatic flushing apparatus may be used, that discharges water as often as may be desired; and a modern device to produce the flow by pressure on the seat, by which a part of the flow occurs before using, works very well. All these appliances should be left exposed, without being inclosed by wood work, as should be the water and soil pipes, unless placed in a large central ventilating shaft arranged to be easily accessible. The soil pipes should extend of full size, upward through the roof, and at the foot of each there should be an inlet-pipe for fresh air; and all the traps should be ventilated by separate pipes carried through the roof. While the floors of all these rooms may be of wood, because it is not as cold for the feet as tiles or stone, the latter should be used around the slop-sink and urinals, and the walls of all such service-rooms should be covered with tiles to the height of five or six feet, with painted plastering above. Space should be provided for keeping, and arrangements for filling and discharging, a portable bath-tub on rollers for each ward.

Fig. 1514.

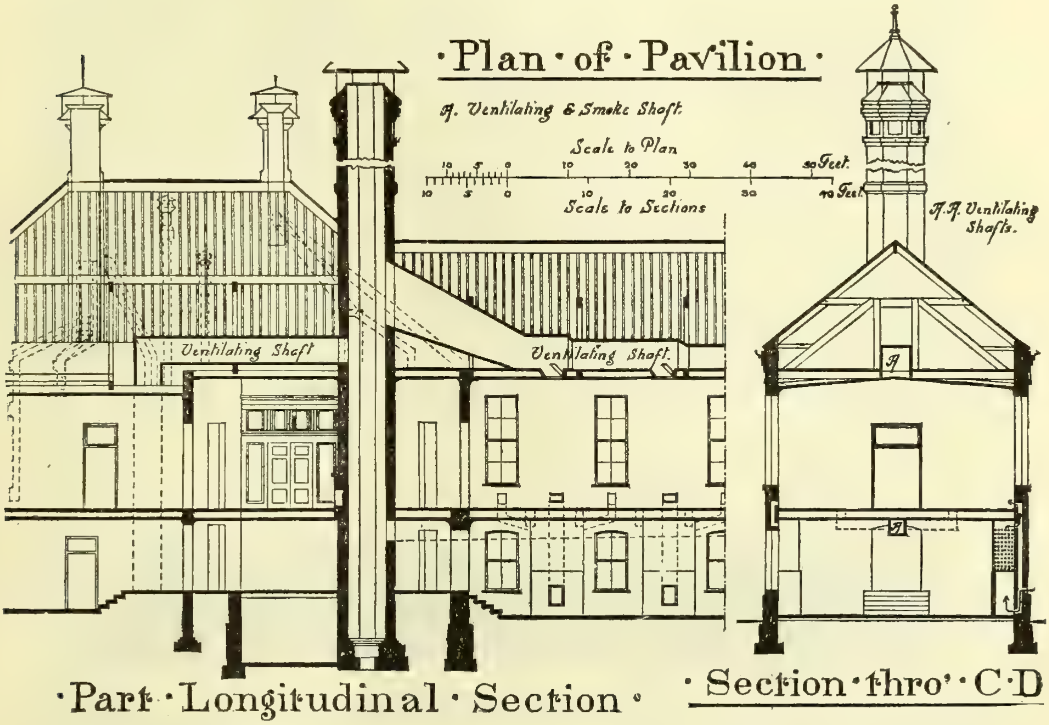


Ward in Johns Hopkins Hospital; scale 40 feet to one inch. A, C, private wards; B, bath-room; D, dining-room; E, linen closet; F, store-room for patient's clothing; K, kitchen; L, lavatory; N, nurse's closet; P, water-closets; V, ventilating shaft.

The plan which is here given (Fig. 1514), of a one-story sick-ward of Johns Hopkins Hospital, which with others has been kindly furnished by Dr. Billings, shows a very complete provision of service-rooms, with a peculiar arrangement of the water-closets and lavatory; the central hall with its large ventilating chimney and open fireplace is a special feature.

A cross-section and part of a longitudinal section of the building is shown in Fig. 1515, and will be referred to again in connection with ventilation and warming. The size of the ward is 90 feet 10 inches long, 27 feet 8 inches wide, and 16 feet average height.

Fig. 1515.



Pavilion of Johns Hopkins Hospital: cross-section and part of longitudinal section.

The square bay window at the outer end is 8 feet deep and 14 feet 8 inches wide. The space per bed is 7 feet 7 inches along the wall, 104 feet of floor area, and 1675 feet of air space. The principal floor of each pavilion is 13 feet above the ground level, and the basement is thus 11 feet 6 inches high under the wards, and 9 feet high under the rest of the building.

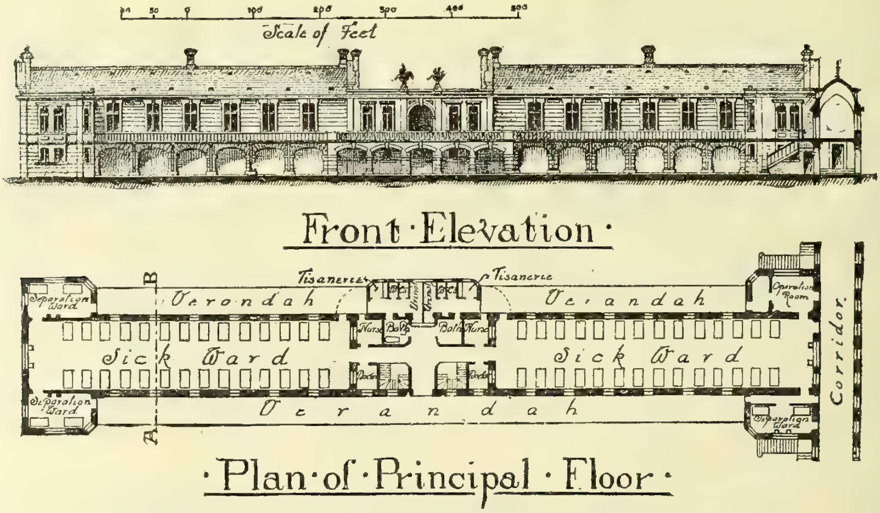
In a two-story pavilion the arrangement of the wards should be the same, with a device for the entire separation of the two wards by having an independent entrance to the upper one, by a stairway leading from the open connecting corridor. The place of this stairway is shown in Fig. 1514.

In Germany there are a number of important hospitals built in part according to the new principles, with one-story pavilions for surgical cases, while some of the buildings have three stories. The Berlin Hospital is entirely without connecting corridors, and in other hospitals these have only roofs and open sides on the principal story, with closed basements. A peculiarity of the Heidelberg hospital is, that its six one-story wards have a capacity of only 16 beds each. These German hospitals show good examples of simply constructed, long pavilion-wards, but, according to the custom of the country, they are planned without attempting to cut off the water-closets from the wards.

In France a notable innovation has been made in the form of hospital wards, by the introduction within the last ten years of the system devised by M. Tollet, an eminent engineer. The "Tollet system" has been applied to many buildings, such as military barracks and schools, and to the Bourges, St. Denis, Bichât and Montpellier hospitals, of which plans and descriptions are given in Mouat and Snell's excellent work on hospital construction and management. The principle of construction "consists of forming both the sides and the roofs of the wards with curved wrought-iron I-shaped ribs, placed about five feet from centre to centre, and filling in between, at the lower part, with brickwork, and the upper, or roof portion, with tiling and brickwork, or concrete. The outer surfaces of the roof are finished with a coating of cement or tiles, and the inner surfaces with plaster, upon which is laid three coats of oil paint."

The novelty of the form consists in finishing the interior surface of the walls and roofs in the shape of a pointed Gothic arch. It is claimed that such buildings are incombustible; that they do not absorb disease germs; that the free passage of air is not checked by sharp angles; and that it is always possible to cleanse the inside surfaces with gas-flames or flush them with streams of water. The ventilation is effected mainly by windows and doors, and largely by inlets under the windows and outlets in the apex of the roof a little way below its ridge. These openings are provided with valves. In some of the wards, small upper windows are placed about half way up, on the curved side of the roof. It is a part of the system also that the sick shall be divided into small numbers in one-story buildings, and that these shall be raised high above the ground upon open arches; and that the water-closets shall be entirely detached from the wards by means of cross-ventilated lobbies. The Bourges Hospital furnishes almost the first example of this modern arrangement in a continental hospital. The St. Eloi Hospital at Montpellier is now almost completed.

Fig. 1516.



The Tollet system.

A plan and elevation of one pavilion are shown in Fig. 1516. (This and Fig. 1518 have been taken from the work of Mouat and Snell by the courtesy of the authors.) The form of the roof is shown in the section of the corridor, on the right of the drawing of the front elevation. This corridor, connecting all the principal wards, except the isolation, lying-in, and puerperal-fever wards, is covered by a roof, but open at the sides. That part of the corridor which is between the buildings is supported on arches, and the basement is open like that under the wards ; but the space under this corridor and adjoining the building is closed in, forming a narrow room which is used for a convalescent ward of eight beds.

The wards, of 28 beds each, are larger than those in the other hospitals mentioned, and the water-closets, instead of being placed in a continuation of the axis of the ward, are in an annex that projects from the offices, forming the central block of each double pavilion; and they can be reached from the ward only by passing out on the balcony which in this part is covered by permanent roofing. Verandas run along the outside of each wall, and in fine weather the beds may be wheeled out upon them through the casement windows. Awnings can be drawn over these verandas. The new Army and Navy hospital at Hot Springs, Arkansas, was built on the plan of the "Tollet system."

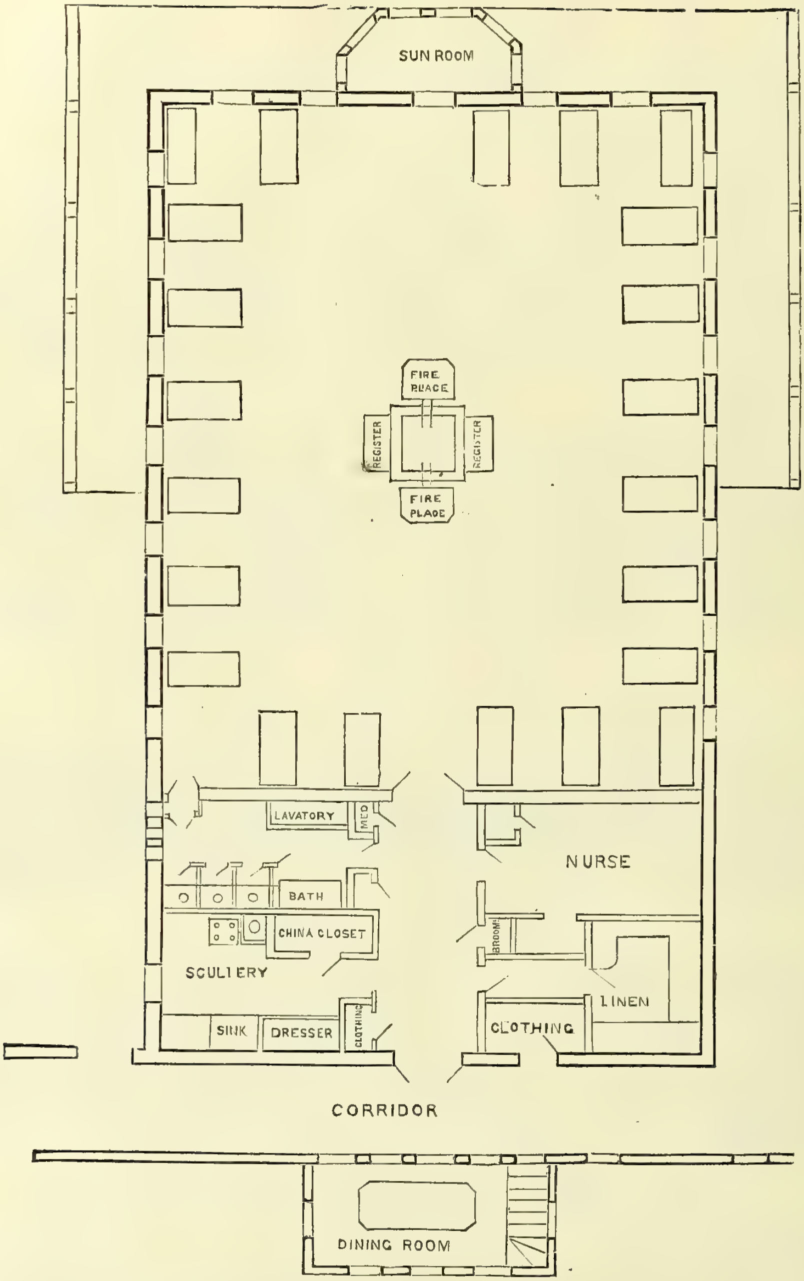
An objection to this system is the height of the wards. It is common in France to build wards 18 or 20 feet high, while in the "Tollet system" the extreme height is 25 feet. The English rule is 13 feet. Reference has already been made to the results of experiments showing that a greater height than 12 feet is probably of no advantage.

Square wards, with central chimneys and fireplaces, have been in successful operation in the main building of the Massachusetts General Hospital for many years. In 1873 two temporary square wards, already referred to, were built, one containing rooms, and the other an open ward. The latter is 44 feet square inside, 16 feet high at the walls, 22½ feet high in the centre, being partly finished into the roof, and is arranged for 20 beds, allowing about 1840 feet of air-space to each bed. The service-rooms are on one side of the ward, adjoining the entrance, and there are 14 windows of ordinary size, with hinged transom windows over them, arranged on the other three sides of the ward. In the centre of the ward is a chimney stack, on two opposite faces of which are open fireplaces, and on the other two, open Franklin soapstone stoves, the flues of which are four iron pipes placed inside the stack. Auxiliary heat is furnished by four steam radiators hung under the floor. Additional ventilation upward is provided for by 4 registers in the ceiling, opening into a large central roof-ventilator; and downward by 12 registers in the floor, through ducts under it which lead to the stack-flue. Dr. Folsom's plan for such a ward provides for 23 patients in a room 56 by 43 feet, with increase of space for service-rooms as shown in Fig. 1517. An improvement could be made in the arrangement of the water-closets. The Warren ward, described above, has been in satisfactory use for ten years, and its cheerfulness is very pleasing.

The new Civil Hospital at Antwerp has attracted much attention because it is the first one having circular wards. Besides the usual service-buildings, it consists of eight circular pavilions of two stories each. Connected with them by separate bridges above and below, there are, on one side a small building containing bath-room, lavatory, etc., and on the opposite side a larger annex, with three separation-wards, stair-case, etc.

Each of these wards has a diameter of 61 feet 6 inches, and an average height of 17 feet, giving each patient about 149 feet of floor-space, and 2525 feet of air-space. A space is divided off in the centre for the nurse. Each ward has 18 windows and 20 beds. The ventilation is effected mainly by windows, in moderate weather. At other times fresh air is driven into the wards by fans, and the foul air is removed

Fig. 1517.

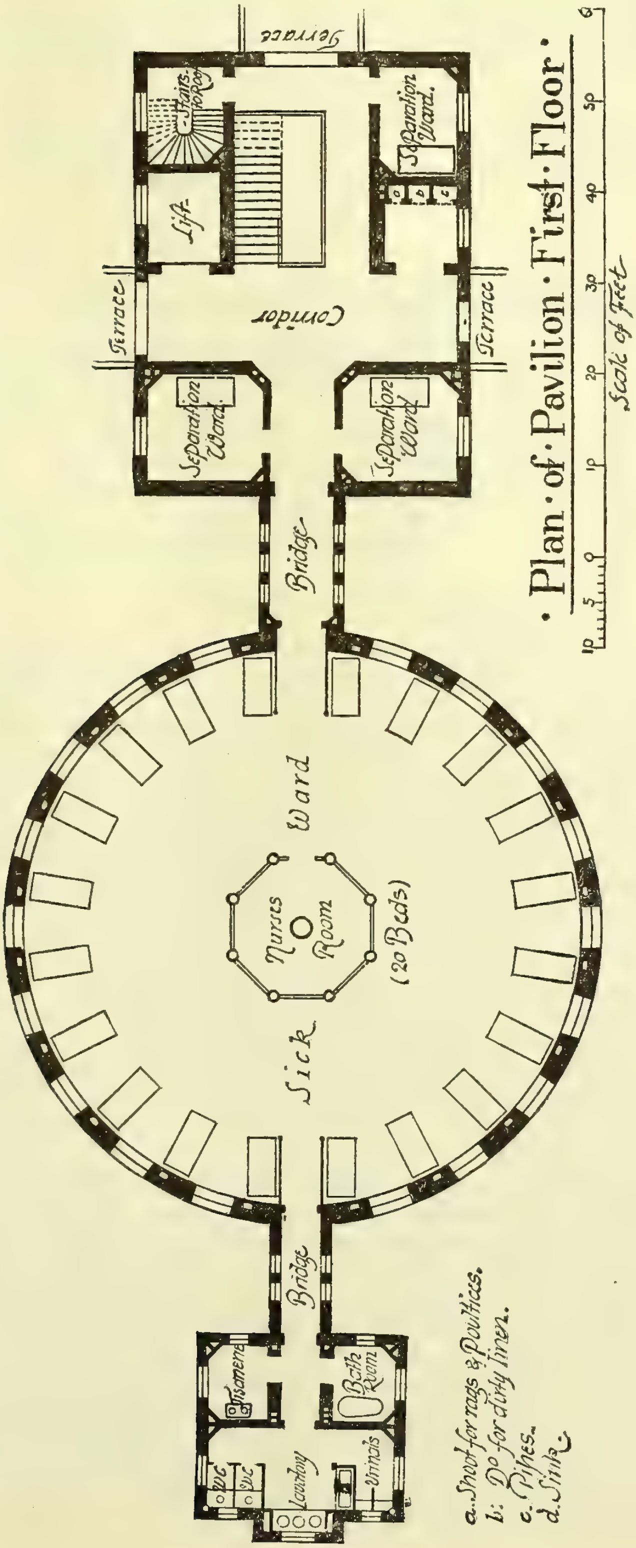


Square ward.

by flues beginning at the outer wall, at the head of each bed, and leading under the floor to a large iron shaft, which passes vertically upward through the centre of the building. The floor plan of one ward, shown in Fig. 1518, is from the work of Mouat and Snell.

An octagon pavilion, two stories high, for 24 beds in each ward and with service-rooms arranged similarly to those shown in Fig. 1514, and built

Fig. 1518.

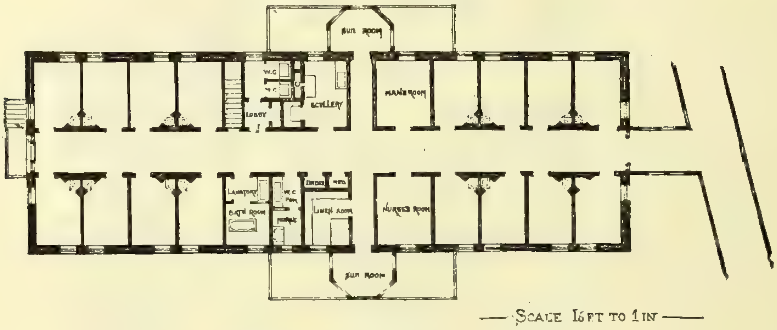


Antwerp Hospital.

according to a plan by Dr. Billings, forms an interesting feature of the Johns Hopkins Hospital.

Two or more isolating wards, at least one for each sex, are essential for every hospital. They should never be of more than one story. They should be divided into single rooms, and should have abundant air-supply and ventilation, and facilities for the practical isolation of each patient if necessary. Such a building was erected in 1874, at the Massachusetts General Hospital, called the Bigelow Ward; a plan of it is shown in Fig. 1519. It has done excellent service, and has formed the model of a more elaborate and expensive building of the Johns Hopkins Hospital for the same purpose.

Fig. 1519.



Isolating ward. Scale 33 feet to one inch.

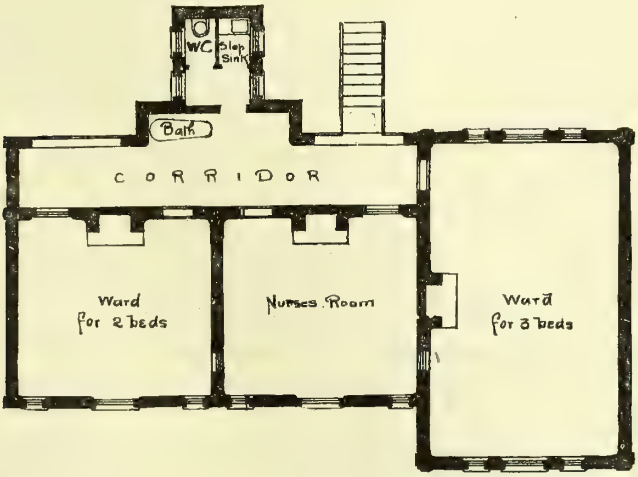
The building is of brick, with double walls, 20 feet high on the outside. It is divided longitudinally by a hall 8 feet wide and 24 feet high, covered by a monitor roof, with windows opening inwards, and warmed by fresh air passing over steam radiators under the floor; the ends of this hall are chiefly of glass. The rooms, 8 by 12 feet each, are only 13½ feet high, and thus the high and airy hall bears to them the relation of the outer air. Fresh air is introduced into each room at the rate of 8000 feet per hour, and there are ventilating outlets at the top and bottom of the room, besides through the corner fireplace. The cost of the building was $27,000.

For the treatment of certain cases of infectious disease, small and cheap wooden huts are very useful. The chief requirements are that they shall be raised above the ground, shall be ventilated through the ridge-pole, and shall contain within themselves everything necessary—a small kitchen, nurses' room, water-closet, etc. An excellent cottage of this kind, 20 feet square, for two patients, was planned by Dr. Wylie for the Presbyterian Hospital, in New York, and is described in the Handbook for Hospitals published by the State Charities' Aid Association of that State. More permanent and properly constructed pavilions, strictly isolated, for small numbers of such cases, have been used successfully as adjuncts of large hospitals; and in case of epidemics, and for regular summer use for surgical and other patients, while permanent wards are being renovated, as is the custom at the Boston City Hospital, tents are of undoubted value.

At the London Fever Hospital, a small isolation-building of interesting character, planned by Mr. Keith D. Young, has recently been built. A ground plan of this building is shown in Fig. 1520, with the courteous permission of the architect, of whose written description a brief abstract is given.

It is raised upon arches 3½ feet above the ground, which is excavated 4½ feet and covered with concrete, giving a clear way through, under the building. The corridor is entirely open, so that the three rooms open to the outer air. The walls are entirely lined with glazed brick, and the floors are of oak blocks laid in asphalt and concrete. The entering fresh air is warmed in its passage around the grate in the fireplace. This building is designed for paying patients.

Fig. 1520.



London Fever Hospital.

The arrangements of the laboratory, water-closet, and bath-room have been described. All other service-rooms, as well as these, should be well lighted. The nurse should have a cheerful, sunny room, if she must live in the ward building. For economy alone, to say nothing of good health and better service, a separate home for nurses is an advantage, as is shown by the experience of hospitals which have made such wise provision.

The fittings of the dining-room and scullery should be simple in construction, the shelving for crockery should be open, and all the plumbing should be exposed, with no inclosed spaces under the sinks, etc. There should be a gas-stove, means for keeping food warm, and a small refrigerator; a broom-closet is essential. The medicine-opening from the hall, by having glass in its door, exposing its contents, will be more tidily kept, and should be supplied with hot and cold water, a bowl and marble slab. The rooms for linen and patients' clothing, should have no drawers; but shelves of wooden slats, and narrow, shallow stalls along the wall, equal to the number of beds in the ward, will be found cleanly and convenient.

Size of Hospital and Arrangement of Wards and Accessory Buildings.—A hospital of a private character built by a benevolent association, or by an individual, will have its size determined by the amount of the fund provided, or which is likely to be available from any source of future support. Municipal and other public hospitals are usually built in part at first, and additions are made according to the increase of the population to be served. The character of the poor differs so much in different cities as to being self-supporting and in so many other ways, and the provision of hospital accommodation for the sick is so various in kind and amount, that there are no reliable data for determining the correct proportion of beds in general hospitals, required for a given population. In 1867, Dr. Oppert estimated that there should be four beds for every 1000 inhabitants of London. This is probably too large an allowance for American cities, in some of which 2 per 1000 would be ample for the total of strictly general hospitals for the poor, including almshouse hospitals, and excluding those for special classes of cases and for the insane.

It is enough to say that the natural growth of any important hospital should be provided for in its foundation. There should be extra ground-space, and its administrative parts should be planned for the probable enlargement of the work. The cardinal principle should be maintained, that there must be simplicity of construction, and wards of only one or two stories; and to build only as far as the money will go, rather than to gain capacity by increasing the height of the buildings.

The arrangement of the ward-units of construction may now be considered in relation to each other, and to the other buildings; and it will be assumed that there is to be a capacity of 200 or 400 beds. In every hospital there should be a separate one-story ward for the more serious surgical cases, for each sex. Surgical patients without open wounds or febrile conditions, as a general rule, may be placed in two-story pavilions, but the distribution of some of these cases among the more serious ones lessens the aggregation of the latter. Children's wards may be in such a two-story building. There should be a completely detached surgical isolating ward, even if it must be a small one, for each sex.

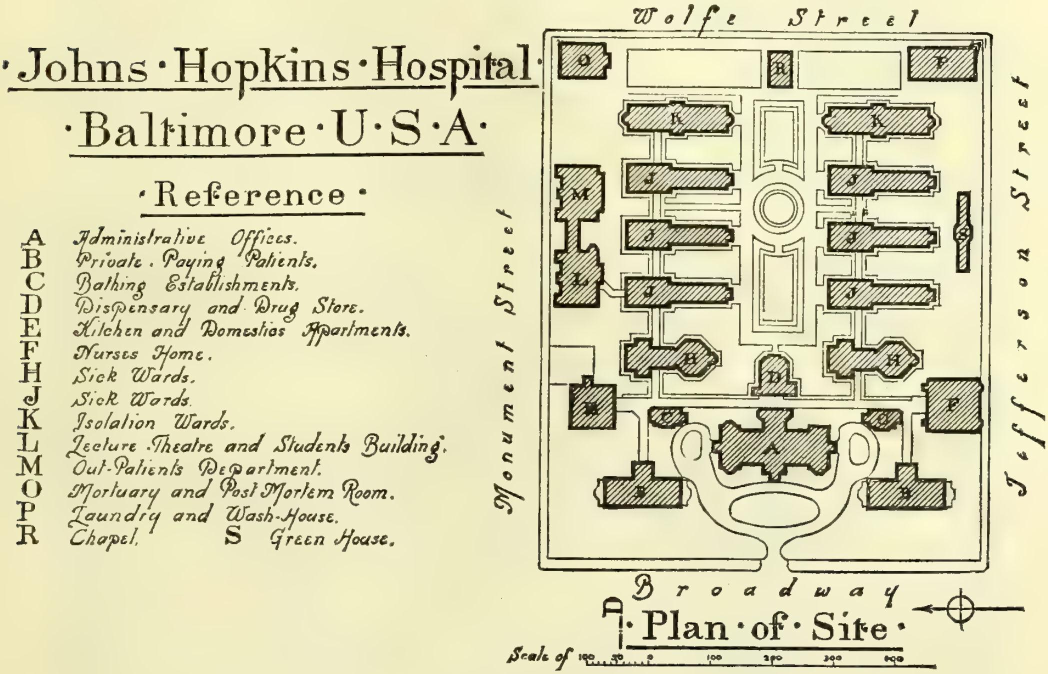
An important adjunct of the surgical service is an operating theatre, having a good skylight with a northern aspect, and the size of the room will be determined by the number of students in attendance. Convenient rooms should be provided for the use of patients before and after operations, a room for administering anæsthetics, a splint-room, etc. The accident or receiving room should be of good size and well lighted, and may conveniently be in the same building. There should be a surgical office or consulting-room, and, as the centre of the whole surgical service may properly be here, a room also for house pupils and their work, and one for the supervising ward-master of the service. The out-patient department may be included in a separate section, and with a different entrance, in the same building; but it is better to have it by itself, and it should certainly be kept out of the administration-building. Economy of service is gained, besides other advantages, by having only one public entrance to the hospital grounds, and one porter's office. This should be in the same building as the out-patient department, and the people who visit the latter should be limited to this building, in which also those who come on visiting days to see their friends in the wards may be gathered at appointed hours, and sent to different parts of the hospital without intruding upon the precincts of the administrative offices.

The medical department should have a one-story building for a fever ward for each sex, and one or more small, detached, isolating wards for infectious diseases; but a larger proportion of medical than of surgical cases of certain kinds can be put in two-story buildings. In a large hospital, it will be convenient to establish a central arrangement of two or three small offices, and a receiving and examining room for the staff and the supervisor of the medical service. All new patients may be received here by a separate entrance, as in the surgical department. In connection with these offices there may be a laboratory for chemical examinations, use of microscope, etc. It is a very convenient arrangement to have these surgical and medical centres close to the administration building, but separate from it, with speaking-tube or telephone connections; and these two centres may be in buildings the upper two stories of which may be used for paying patients, or which may contain small wards for special classes of cases, as in the Boston City Hospital.

A general plan of the Johns Hopkins Hospital is given in Fig. 1521. The building marked F is on the south side of the grounds, and the ward-buildings shown in the plan, in the rear of it, are not to be built at present. The separate location of the laundry, etc., is to be noticed. In Fig. 1522 is a ground plan of the Boston Hospital.

It is the rule that hospital buildings should be separated from each other by a distance not less than twice the height of their upright walls. At the Johns Hopkins Hospital this distance is three times the height. As a general rule, the direction of the wards should be from north to south, or from northeast to southwest. In very warm climates, however, there is reason for having them lie east and west, with a veranda on the south side.

Fig. 1521.


·Johns·Hopkins·Hospital·
·Baltimore·U·S·A·
·Reference·
A Administrative Offices.
B Private. Paying Patients.
C Bathing Establishments.
D Dispensary and Drug Store.
E Kitchen and Domestics Apartments.
F Nurses Home.
H Sick Wards.
J Sick Wards.
K Isolation Wards.
L Lecture Theatre and Students Building.
M Out-Patients Department.
O Mortuary and Post Mortem Room.
P Laundry and Wash-House.
R Chapel. S Green House.
Wolfe Street
Monument Street
Jefferson Street
Broadway
·Plan·of·Site·
Scale of 100 50 0 100 200 300 400
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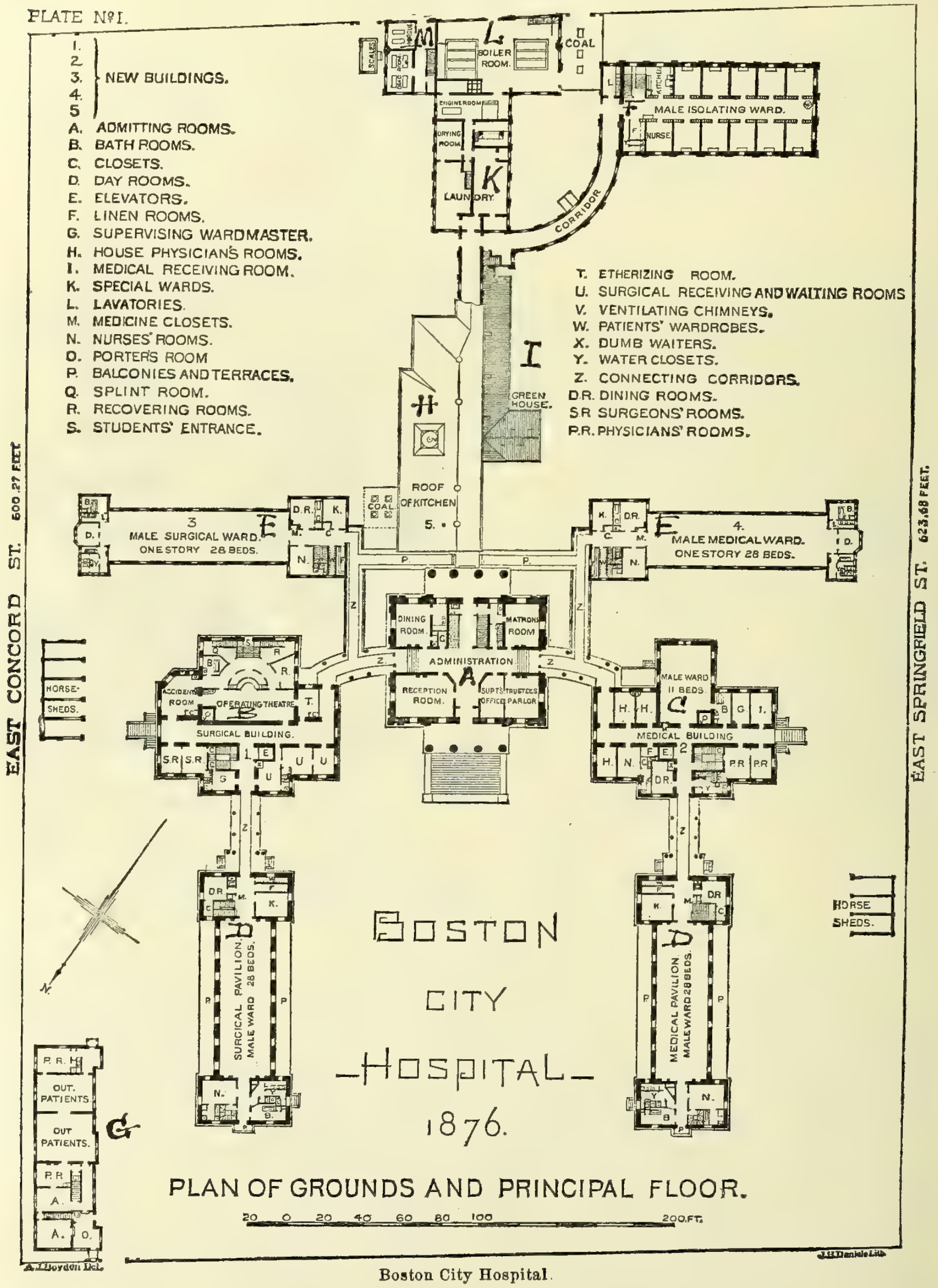
Johns Hopkins Hospital.

Such arrangements as are shown in Figs. 1521 and 1522, localize the work, give a distinctness and unity to each service—surgical and medical—and form organizations that promote ease of management, while they disencumber the main administration department of much worry and confusion that must arise in a large and busy hospital, if all its affairs, internal and external, are conducted in a series of adjoining offices.

The plan of organization should be considered beforehand, and, whatever it is, the arrangement should be such as to locate conveniently and distinctly each part of the service, and to prevent confusion.

The administration-buildings in large hospitals should contain, on the first floor and in the basement, only the rooms to be used for general business purposes. There should be a general reception-room for visitors who come to do business with the superintendent; the offices, public and private, of this officer—and the latter room, if of good size, may serve also for the occasional meetings of the trustees; a large room, or suit of rooms, for a medical library; an office for a superintendent of nurses, if desired; and one for the steward or purveyor, although more room can advantageously be given this officer in a high basement, and he will thus, with his storekeeper, be located nearer to the store-rooms, and supervision of the kitchen, etc., which should be placed in adjoining buildings, will be facilitated.

Fig. 1522.



Boston City Hospital.

In the basement there may be also the linen store-rooms, and the dining-rooms of the employés, and those for nurses, unless provided elsewhere; and the dispensary should be here, or in an annex, to remove its disagreeable accompaniments from the main building. Such an arrangement can be comfortably made in a basement story 10 feet high, with its floor 4 or 5 feet below the ground-level, and good windows can be had by "banking off" the earth in front of them. Corridors leading to other service-buildings may have closed basements, with the same floor-level; and other corridors may extend to the pavilions, currents of air being prevented from entering the wards by a proper system of swinging doors. Such convenience of communication is of great importance in cold climates for many purposes, besides furnishing a way for steam and water pipes, etc., and for carrying food in a satisfactory manner. There can be, very easily, an absolute cut-off of air-way in such a corridor-basement, by making a bridge of a short section of it, or by leaving the sides open with wire guards and projecting roofs to keep out rain and snow; and there may be doors both ways from this open space, thus making a short covered way at any desired point near a pavilion or other service-building. On the principal floor these corridors should have entirely open sides, or at least sections of them should be open. Terraced walks on the corridor roofs are very useful in connecting the two-story buildings.

The administration-building need not be as large as it is often made, and a good general rule for the arrangement of its offices is, that all business between its chief office and the outside public, including the visiting medical staff, etc., should be done on the first floor; and that all business pertaining, in the main, to internal domestic affairs, and requiring communication with the wards, should be done in the basement offices by way of the corridor connections. This avoids confusion between public business and the internal concerns of the household. The upper stories of this building should serve only as the residence of officers and house-servants. The provision of a certain degree of domestic privacy and comfort is not only humane, but has its product in the general welfare, in the better service that can be given on a basis of good health. To the same end, a separate residence for the superintendent of a large hospital has definite economic value.

The kitchen building should have its complement of rooms for cooking appliances, bakery, store-rooms, refrigerators, etc., and, with its floor a few feet below the level of the ground, its roof need not be more than 10 or 12 feet above. This building should be of one story only, for the most part, and its principal rooms should be well lighted and ventilated, and made airy by a monitor roof. Thus it will be comparatively low, the air will circulate more freely over it and among the buildings, and the winds will traverse the hospital grounds with less obstruction. The same rule applies to the laundry building, but this, for some reasons, is more convenient if placed on the ground level, in which case there is no objection to having the service-corridor incline upward, but there should then be an effective cut-off at its connection with the laundry. If this building be suitably placed, the ironing-rooms and drying-rooms may be in a second story, and less ground-space will be occupied.

There should be, apart from the laundry proper, a rinse-house, to which all badly-soiled clothing and offensive dressings should be taken at once from the wards, in tight metal pails, for a preliminary cleansing. The disinfecting-room should be in this house, fitted with apparatus for applying dry heat or superheated steam to articles of clothing, mattresses, etc. An excellent chapter on the hospital laundry may be found in the "Handbook for Hospitals" already referred to.

The boiler-house generally requires that its floor shall be at a lower level than that of other buildings, and for this purpose advantage may be taken sometimes of sloping ground. This building and the laundry should be near together, for economy in steam and care of machinery, and should be placed at the rear of the grounds, with an entrance from the back street.

The housing of kitchen and laundry servants should not be over the work-rooms of the two departments, and if possible a separate place should be provided for each. This should never be in the administration-building, but there may be an annex, in which the servants can have rooms, over basement and first-floor offices, etc.

The dead-house is naturally placed in a building with the autopsy-room, and the rooms of one may be above those of the other; they should be properly fitted for their purposes with tiled floors and walls, marble slabs, a ventilating autopsy-table, and a good skylight.

For the nurses, the best plan is to have a separate "home," in which each nurse shall have her own bedroom. The superintendent of nurses should also have her rooms there, and the building should contain a class-room, a library, a pleasant sitting-room, a dining-room and kitchen, a sick-room, bath-rooms, etc. In default of such a building the nurses are usually placed in rooms next the wards, or in the upper rooms of the "head-houses" of the pavilions; in which case the rooms should be of good height, and the roofs should be built for proper coolness in summer. Nurses should not be placed in the administration-building.

In smaller hospitals, much ingenuity can be used in adapting the more or less limited space to all their various requirements, but usually due regard may be given to the proper relation of things that should not be put together. A good example of a small hospital may be seen in Figs. 1525 and 1526, showing plans of the Barnes Hospital in Washington.

VENTILATING, WARMING, AND LIGHTING.—The "*natural ventilation*" of hospital wards, which has been largely provided for in what has been described as proper for their form and construction, includes also the air-supply, and relates to the means employed in warm weather, when advantage is taken of the natural movements of the air, without the use of heat or other artificial means. The favoring conditions required are best afforded in a large ward or room of the prescribed width, with opposite windows, through which and the doors, when open, the air may move freely in and out. The transom windows, and such appliances as the "Sheringham valves," placed near the ceiling, arranged to deflect the air upward and prevent draughts from falling upon the patients, are useful. Fresh air may be introduced near the floor, behind the head of each bed, through perforated-brick or larger openings in the wall, with perforated metal screens on the inner surface to break up the currents of air. For the purposes of natural ventilation, use may be made also of openings in the upper part of the walls, or of the ridge ventilation of one-story wards; or of openings in the ceiling leading to a ventilating chimney, which has the advantage of affording means of applying heat to aid in the process of extraction.

The amount of air-space prescribed for each bed, is based partly upon the requirements for natural ventilation; and it bears an important relation to all the questions of warming, ventilating, and the necessary air-supply, when the natural inlets to the ward must be closed or little used, as in cold climates. It is difficult to change the air in a room, with comfort to the occupants, oftener than three times in an hour, and it will naturally be less, even in well-ventilated wards. De Chaumont says that the air-supply should not be less than 4000 cubic feet per bed, per hour, in ordinary cases of sickness, and this would require an air-space of 1333 feet per bed, which agrees with the rule already given in regard to the construction of wards, as the space above 12 feet should not be reckoned. Billings defines ventilation as including, besides the securing a change of air, "the idea of a thorough mixing of pure air with impure air, in order that the latter may be diluted to a certain standard," and says that this is "good ventilation," and all that is practically attainable. Sanitarians generally agree that the amount of air-supply required, is that needed to keep an occupied room free from perceptible odor to a person entering it from the outer air. The measure of impurity is the percentage of carbonic acid as a product of respiration; and when this is increased from the normal ratio of between 3 and 4 parts, to between 6 and 7 parts, in 10,000, a faint musty odor is usually perceptible. In order that the air of a continuously occupied room should not have this odor of impurity, it is shown by Parkes that the air-supply should be 3000 feet per hour, to maintain this standard of dilution. Billings's rule is a most convenient and practical one, that heating surface, foul-air and fresh-air flues, and registers, should be provided for an air-supply of 3600 feet per hour.

To avoid perceptible currents of air in a room, its movement should not be more than 1½ feet per second, anywhere except at the point of entry, where, even if warm, it should not exceed 5 feet per second; and with a clear inlet-area of 72 square inches per head, according to the generally accepted rule laid down by Parkes, the amount of inflow will be 1½ cubic feet per second, at an average velocity of 3 feet per second, or 5400 feet per hour. This amount of inlet-area is necessary to provide for occasions when unfavorable atmospheric conditions will cause a slower movement.

Taking up now the subject of properly *warming* the air-supply in various climates—from those in which there are brief seasons of cool weather, to the more northern regions of the temperate zone, where provision must be made for variations from 30° or 40° below zero, to 100° F. above—the great variety of methods must be considered here in regard to general principles, and with but little of detail. Open fires may be depended upon in very mild climates, and for occasional heating are useful and very desirable in all small rooms; and for large wards as well, in cool or dull weather in the spring or fall, and as adjuncts to the principal means of heating in the winter season of the colder climates. They have a particularly cheerful effect in the centre of a square ward; and the Galton fireplace, and various other devices, are contrived for being placed at two or more points in long wards, and so arranged that the fresh air may be warmed, before entering the ward, by passing through spaces behind the grates. The smoke must be conveyed away by flues under the floor, to the chimneys in the walls, and there is sometimes defective draught, as the flues get cool quickly. They have been used in some small army hospitals in this country, and Billings says that "at times it appeared as if the inmates might be frozen to death by their own fireplaces." Improvements have been made in these appliances both in England and in America. The "thermhydric grate," invented by Mr. Snell,[1] in use at the St. Marylebone Infirmary, works in an excellent and satisfactory way. The sides, back, and top of the fire are surrounded by a wrought-iron case containing water, and communicating by short tubes with upright coils of pipes, so placed on either side that the water when heated by the fire circulates through them. The heat of the surface to which the air is exposed as it enters around these pipes, is not more than 212° F., and the expanding water in the apparatus rises into an urn-shaped vessel on the top, and gives off a slight vapor for moistening the air of the room. The smoke-flue passing under the floor is embedded or encased in sand, which retains heat and prevents the cooling of the flue, and above this there is a channel in which the fresh air becomes somewhat warmed before it reaches the grate. The apparatus is also adapted to a position by the wall of a room, and in several English hospitals is the sole means of heating, proving also to be economical of fuel.

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[1] Mouat and Snell, op. cit., Part II. p. 62.

In barracks and temporary hospitals, effective use is made of large cylinder-stoves with jackets of sheet-iron or zinc, the space within which is connected with the outer air by an opening in the floor and an inlet-flue, the air being warmed as it passes by the stove before entering the room. A simpler device is to place such a stove, with a movable jacket provided with an open side, before a window which may be opened more or less. Figs. 1523 and 1524 are illustrations of arrangements suggested by Dr. D. F. Lincoln in a paper on "School Hygiene," in the report of the N. Y. State Board of Health for 1881–2. The entrance of fresh air by these means is promoted by a complementary device for ventilation; the stove-funnel being carried to a large flue or chimney, is made to warm the air therein and create an upward current, through an exit-opening near the floor or higher, in the especially constructed flue, or through an unused fireplace. These arrangements do very well for small rooms, but in a large room occupied by many persons it is difficult to introduce fresh air and distribute it satisfactorily, by any form of stove placed in the room itself. As a rule, it is always best to place the stoves, which thus become furnaces, in the basements. This is a more effective means for giving an ample air-supply, but the use of furnaces is attended by special dangers and inconveniences.

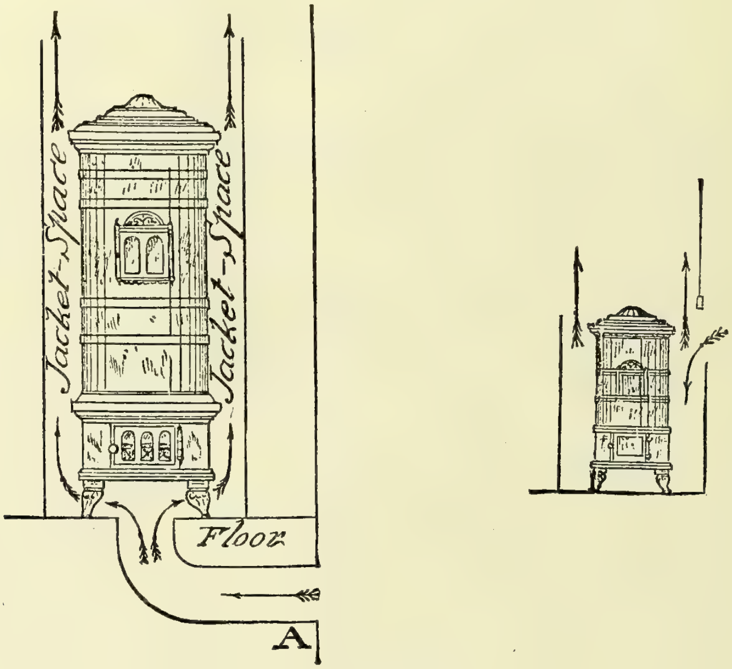


Fig. 1523. Fig. 1524.

Stoves for hospitals.

In permanent hospitals, the safest, cleanest, and best means of heating is by indirect radiation from coils of steam or hot-water pipes, placed at many points near the basement-ceilings, in encased chambers, receiving fresh air directly through the outer wall.

Steam-heating apparatus is commonly used in this country: it costs less at the outset; workmen are more accustomed to the making of boilers and fittings for the use of steam; and there are few manufacturers of hot-water apparatus. For these reasons, repairs of the latter would be more inconvenient and costly, although they ought in the long run to be less so, because the apparatus is subject to much less wear. In a steam apparatus, heat can be generated more quickly, although it requires more constant attention to keep up the supply. One of the special reasons for the use of the hot-water apparatus is claimed to be, that the air is warmed by a large surface at a comparatively low temperature; but in the series of experiments at the Boston Hospital, to which reference has been made, while the external temperature was ranging from 17° to 50° F., the temperature of the entering air at the registers, in three daily observations for a week, varied only from 90° to 96° F., and this with an average hourly supply per bed, of over 9000 feet on every day.

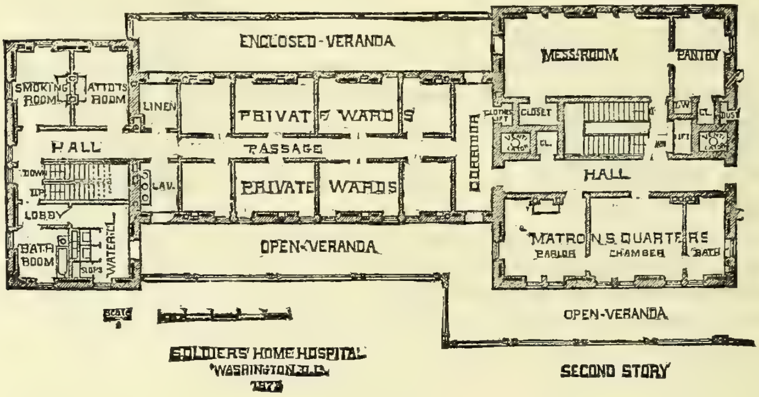
The heating centre in a large hospital is most economically placed, as a rule, in a single boiler-house. The low pressure system is to be preferred, with the water of condensation returned directly to the boilers. The pipes should be large enough to permit the free flow of steam, and should be well protected to prevent waste of heat. There should be a radiator at the foot of each inlet-flue for fresh air, a valve for controlling the amount admitted through the opening in the outer wall, according to the temperature of the entering air, and a switch-valve to be worked from above, by which the air may be directed over the hot pipes, or allowed to pass by them without being warmed. Thus, varying proportions of hot and cold air may be mixed in the inlet-pipe above the radiator, affording the required temperature at the register in the room above, without lessening the quantity of air supplied.

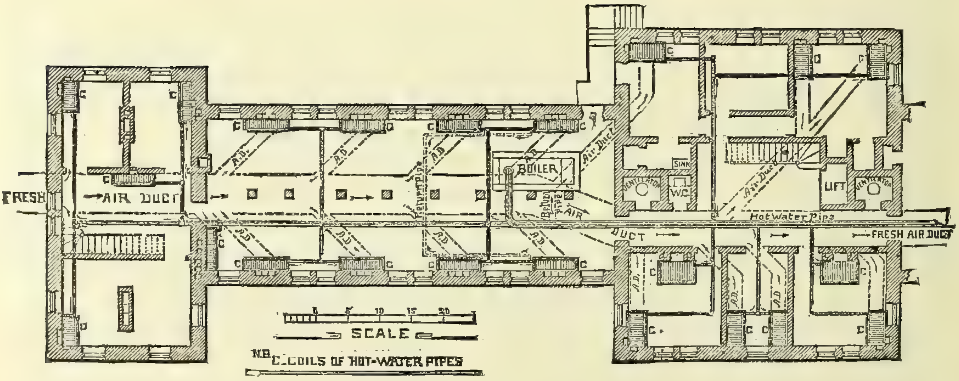
The use of a fan and long ducts, with branches leading to the radiators, as a means of introducing air by *propulsion*, is valuable as affording a certain and absolute control of the air-supply. The great value of the fan is, that by its use the wards may be rapidly flushed out with large quantities of air, in the morning and evening. Experiments at the Barnes Hospital have shown that the use of the fan for ten minutes made the very impure air of a ward which had been closed for some time for the purpose of the test, nearly as pure as the outer air.

The air-supply should be well distributed in the large rooms. It should be brought in at the lowest part of the rooms and large wards, and the inlets may be located with advantage in the walls under the windows, thus warming the air that is chilled by them. There is also an advantage in placing the inlets midway between two windows, and thus between the heads of two of the beds, thereby serving to sweep out the air that may become stagnant between the latter. This is easily done in one-story wards. When an upper ward is to be warmed, the flues must be carried up in the thickness of the walls, if possible where there are piers that increase the thickness, and in terra-cotta or metal pipes, to prevent loss of heat. In a ward so arranged that there is one inlet for every two beds, each inlet should have at least one foot of clear opening, which is equivalent to 72 square inches per bed as prescribed. There should be a separate and ample air-supply for each of the service-rooms, separation-wards, etc.

The *ventilation* proper, by outlets for the escape of foul air through openings in the ceiling, with ridge ventilation, or flues leading to an aspirating chimney, has been considered to some extent in connection with other matters, and is a necessary complement to the arrangements for supplying fresh air. The outlet-openings should equal, at least, the area of the inlets. In a one-story ward there may be six or more such openings, according to the number of beds, and an allowance of one square foot of opening to each bed, making a total of 4 square feet in each of the 6 openings for 24 beds. These may be partially closed by hinged flaps in winter, and left open in summer, the foul air passing into a long, narrow, ventilating chamber in the ridge, and thence out through ventilators by a process of natural ventilation. In place of such a chamber, a duct, increasing in size as it takes in the air from each ventilator, may lead to an aspirating chimney, as in the wards of the Johns Hopkins Hospital. (See Fig. 1515.) This aspirating shaft is octagonal, 4 feet 8 inches in diameter, and 60 feet high above the level of the ward floor; it is heated by a coil of pipes placed above the level of the roof-ridge. Similar extraction-shafts, smaller in size, are provided for service-rooms and separation-rooms. Additional ventilation is obtained through gratings under each bed, and ducts leading diagonally into an iron channel under the basement ceiling. This channel extends along the axis of the ward, and opens into the aspiration shaft below the floor level.

Fig. 1525. Fig. 1526.





Barnes Hospital; plan of basement and principal floor.

In Figs. 1525 and 1526, are shown the basement and first-floor plans of the administration-building and of one ward for 12 beds of the Barnes Hospital.

The buildings are of brick, the central one three stories, and the pavilion wings two stories high. The wards of 12 beds each are 50 feet long, 24 feet wide, and 15 feet high. The heating is by coils of cast-iron pipe for hot water, placed in fresh-air chambers in the basement, as shown in the plan. A large brick air-duct leads under the building from a shaft 8 feet in diameter, and 30 feet high, placed 74 feet west of the building. At the junction of the base of this shaft with the fresh-air duct, is placed a fan 8 feet in diameter, which drives the air along the duct at a velocity of from 400 to 600 feet per minute. Foul air is removed by two aspirating chimneys, about 5 feet in diameter, in the central building. These chimneys are heated by iron smoke-flues in their centres, and into them open the foul-air ducts, placed above and below the centre of each ward, with which they communicate by registers.

A good description of this excellent building may be found in Dr. Billings's valuable work on "Ventilation and Heating."

In the smaller rooms and in all separation-wards it is desirable to have outlets, leading to a warmed ventilating shaft or chamber, at the bottom as well as the top of the room, but these should be on the opposite side from the inlet. The upper opening can be closed when in very cold weather it may be difficult to warm the room, and the lower one will work when the fireplace may not be in use. All the service-rooms should be independently ventilated. A central pipe-shaft, as suggested for the water-closets, may be large enough to serve as a ventilator, and, containing the soil pipe, may be extended upward through the roof. Besides the usual hot-water pipes, the gas-jets may aid in ventilation, by being placed within the shaft, with small windows to let out the light for the room; and the waste heat of the water-boiler for the building may be utilized in the same way, by inclosing the apparatus in the basement so that its escaping heat shall pass up the shaft. In general, all heat-producing flues, like smoke-pipes, should be of iron, and should be placed within larger shafts or chimneys, to promote the process of aspiration, for which such shafts may be useful if judiciously arranged. For the additional ventilation of the whole system of drainage-pipes and sewers, it is of great value to run a branch pipe to the boiler-house chimney, in which there is constant heat.

In hospitals for the insane, nurses' "homes," etc., where small rooms are used chiefly as chambers and require to be only partially warmed, this is sufficiently and economically done by introducing air from a well-warmed hall or corridor, through transoms over the doors. The warm air passes along the ceiling, at the same time being diffused downward, to the windows, where the chilling it receives is a motive power that aids in maintaining the process of circulation. The air thus cooled, falls and flows along the floor to the inner end of the room, where, near the floor, are the ventilating openings essential to this system. Through these the foul air is conveyed to a ventilating chamber or shaft, and is replaced in the rooms by the continuous entrance of warm air through the transoms. The air-supply of the hall or corridor should be liberal, warmed by indirect radiation, and allowed to escape only through the transoms into the rooms. For this reason all stairways should be cut off by doors, and ventilators near the ceiling of the corridor should be used only when there is excess of heat, or for changing more quickly all the air of the place.

With the introduction of recent plans of separating pavilions and making them of only one story, there is a tendency to rely upon the simpler means of natural ventilation.

The *lighting* of wards is most commonly and safely effected by the use of gas. In large wards there should be a light over the head of each bed, and, whether there, or suspended from the ceiling in the centre of a room, a special ventilator may be provided to carry off the products of combustion. It is obvious that the electric light will be of great advantage when its use becomes practicable.

Furnishing and Fittings.—The furniture of hospital wards should be plain and simple, and there should be no more than is absolutely necessary, in order that it may be easily kept clean, and may not interfere with the circulation of air in the ward. The bedsteads should be of iron, and substantial enough to be firm, and thus the more desirable and economical. Mattresses of woven wire are very satisfactory, but for the sick there should usually be in addition, for warmth at least, thin mattresses of hair. There may be bedside tables, having shelves with open sides, but no drawers, and comfortable but plain chairs. Portable screens, of non-absorbent material, may be used about the beds, but no curtains. Pictures, flowers, etc., may be supplied in moderation, and will be beneficial.

All fittings should be simple in construction, as has been suggested in the description of the service-rooms. Everything should be contrived with a view to ease of keeping clean and of inspection. All receptacles for utensils should be well ventilated.

Organization and Management.—The general control of a hospital should be in the hands of a board of governors or trustees. In incorporated institutions of a private character, such a board is usually representative of a larger corporation, by which this managing board is elected. Municipal and other public hospitals have their boards appointed by the local government, and are apt to be subject to the vicissitudes of party politics. The stability of control is sometimes guarded by acts of incorporation by the State, and by checks upon the power of appointment of trustees. As a rule, medical men are regarded as ineligible to such bodies of control of public hospitals. The governors or trustees should have entire control of all the business affairs of the hospital, and of the appointment and government of all its officers and servants.

The medical staff should be appointed annually by the trustees, and their duties should be confined strictly to medical and surgical attendance upon the patients, and to the giving of directions, etc., for their care. Beyond this, all responsibility for the execution of such directions rests upon the government of the hospital and upon its executive officers. The responsibility for having good nurses, servants, etc., rests upon the management. The immediate management should be in the hands of a superintendent, responsible only to the trustees, and having entire executive control of all the internal affairs of the institution, and of other officers, all of whom should be subordinate to him. Thus the chief officer may be held responsible for the good or bad management of every detail in the work of the hospital.

The superintendent of a general hospital should be a medical man, and he may exercise his medical functions in supervising the admission of patients, but he should have no charge of the treatment of the sick, except that in the first care of surgical and other cases, when admitted, he may, as a qualified medical man, take cognizance of emergencies, and even direct under-graduate house-officers as to treatment, before the visiting physician or surgeon arrives. He may contribute in a similar way to the welfare of patients in the wards, among whom a grave emergency may occasionally arise, but always on the same principles of medical ethics which would govern a general practitioner, when called in an emergency to a case in the care of a temporarily absent physician, who is his neighbor.

The superintendent should have exclusive charge of maintaining order and discipline, and the regulation of all the duties of the various departments assigned to his assistants. He should regulate the admission and discharge of patients, discharges usually being made upon the recommendation of the visiting staff, and should have the power of appointment, removal, and regulation of subordinates generally, including the nurses, subject to the governing board or its special committees. The business of managing a hospital is of a special kind, and all its details must be ordered for the one purpose of curing the sick. Everything should work together to this one end, and none but a medical man can possess the knowledge by which the object may be gained in the most efficient and harmonious way. Unity of management is essential in such a household, and, as Dr. Mouat says, "those are best qualified to conduct a business successfully who are best acquainted with its requirements."

The purchasing officer, a steward or purveyor, should have the immediate duty of buying supplies, the care and issuing of stores, the control of the kitchen department, etc., and the general care of the buildings and grounds. As a steward he sometimes has charge of the book-keeping and accounts, and acts as a cashier in paying and receiving money, although it is usual for this to be chiefly done by a treasurer, who, apart from the immediate control of the hospital, has the management of the funds. It is far better that the purchasing officer should have no money responsibility, but, simply as a purveyor, perform functions like those of a buyer for a commercial house, besides having charge of the stores, etc.; the care of the accounts and all such matters may then be entrusted to a person who may be called the clerk of the hospital. This officer should have no executive duty or authority whatever, but should serve as a confidential assistant to the superintendent, regulating all the affairs of the office that require attention, and thus saving him from much unnecessary waste of valuable time. The application of this principle in organizing the business of hospitals for the insane is especially valuable, as it can be so managed as to leave to the superintendent most of his time for strictly medical duties.

Under such an organization, the resident or house medical officers, doing duty with the sick as medical assistants, may be under-graduates, and they may serve as clinical clerks, dressers, and house physicians or surgeons, according to time of service. Other subordinate officers, apothecary, storekeeper, etc., require no special mention. The matron, or general housekeeper, should be subordinate to the superintendent of the nursing department, if there is such an officer.

Nursing.—The nursing service should be under the charge of a superintendent of nurses, who should be qualified by a course of training in her duties. She should have one or two day assistants, and a night assistant, to aid her in the inspections of the wards, and in teaching. The best results are gained by the establishment of a school for the training of nurses by a systematic course of instruction. The superintendent of nurses should be responsible to the superintendent of the hospital, and through him to the trustees, for the proper management and discipline of her department, the care of the wards and the sick, and the execution of all orders given by the visiting staff. The latter should refer all matters of discipline of nurses, etc., to the medical superintendent of the hospital, who is responsible for the proper and unquestioning obedience of the nurses to the directions of the medical staff. The superintendent of nurses should also have control of the matron's or housekeeper's department, and through her of the linen store-rooms, sewing-rooms, laundry, etc., and generally of the servants in the house-keeping service. It is well for the housekeeper to be a graduate of the training-school, as she is thus more intelligent and useful in regard to duties that involve relations between her department and the nursing service.

For the sake of unity and harmony of management, the training-school is best placed under the control and regulation of a competent medical superintendent, with trained assistants for the management of the nursing service. The organization of training-schools by associations outside of hospitals has been invaluable, but the attempt to manage the nurses of a hospital by such an outside organization, raises difficulties that are very trying and dangerous to the welfare of both the school and the hospital itself. At the same time, as qualified medical superintendence cannot always be had, because of the political disorders of public institutions, it may be fairly questioned sometimes whether the less desirable method will not best insure the stability of the school in such hospitals.

Special Hospitals.—It is not necessary to consider the great variety of special hospitals for the care of more or less chronic cases, or those which may be as well treated in general hospitals which have well-arranged pavilion-wards for the proper classification of diseases. The principles of construction would be the same in either case. What are called *fever* hospitals may be more largely composed of specially constructed, comparatively small, detached pavilions. The same necessities belong to hospitals for *smallpox*, besides the need of isolating the hospital itself. The Royal Commission of Great Britain regards it as essential, that atmospheric dissemination should be guarded against, and that no more than 30 or 40 patients should be placed together in one locality. Dr. Burdon Sanderson has recommended large one-story annular wards, 56 feet in diameter, with a central ventilating chamber 20 feet in diameter, around which twelve beds are arranged, with low partitions between them. The patients face the windows in the outer wall, thus reversing the better arrangement of the Antwerp Hospital, and Billings's plan for octagonal wards. The recent experiment of isolating smallpox-cases on hospital-ships has been satisfactory, and a large tent-hospital was used in the country near London, in 1884, to receive convalescent smallpox-patients from the city.

Maternity hospitals have an especially lamentable history of disastrous results, particularly on the continent of Europe. The immunity from danger to puerperal women, in English hospitals, has been referred to, and is due to isolation and the allowance of ample space. Some excellent results have been gained in recent years in the small maternity pavilions, of one or two stories, of some of the Paris hospitals. They are arranged with rooms for one bed each, and the principle of construction is, that the entrance to every room is from the outer air, the doors opening upon an open veranda.

Military hospitals are generally temporary constructions, heated by stoves, and with simple ridge-ventilation as already described. There are a few army-hospitals of a more permanent character, of which the Barnes Hospital is the best example. (See Figs. 1525 and 1526.) A simpler arrangement, on the same general plan, is the approved one for post-hospitals of the U. S. Army. The use of extensive aggregations of temporary barrack-pavilions, or of hospital-tents to form long wards, for temporary use in time of war, needs no special description here.

There are in the United States a few *marine hospitals*, which are excellent examples of the pavilion plan—notably the one at San Francisco.

Naval hospitals in this country, before the Civil War, presented no distinctive architecture, but subsequently two or three have been built on the pavilion plan; two of these are at Philadelphia. Naval vessels have been used from time to time as hospital-ships, usually in charge of line officers. The

Pawnee, used exclusively for hospital purposes at Key West, Florida, from 1870 to 1875, is said by Surgeon J. H. Clark, of the U. S. Navy, to have been considered much preferable to any building that could be constructed on shore at Key West. Hospital-ships, under the exclusive control of medical officers of the army, were very successfully used during the late American war.

The modern ideas of what is required in the proper care of the sick and wounded, are nowhere better shown than in the successful use, in very recent years, of well-equipped hospital-ships by the English, under the exclusive management of medical officers—a reform that is due, no doubt, to the recent granting of executive control and management to the medical staff. A similar plan of using hospital-ships was introduced in 1883 in the German navy.

COTTAGE AND CONVALESCENT HOSPITALS.—The merits of the English "*Cottage-Hospital*" system are now well recognized. The hospitals may be small cottages for a few beds, or may be adapted for enlargement by adding rooms, small wards, or detached pavilions, fitting them for use as general hospitals, fever-hospitals, or infectious hospitals, or for convalescents. Mr. Burdett's excellent work on the subject fully describes the construction and best methods of organizing and managing such hospitals. Their great merit is, that at a comparatively small cost, there may be a small and serviceable hospital in any community of moderate size and enterprise, and that it may be so managed that all classes may enjoy its advantages, and with any medical attendance that may be desired. Mr. Burdett recommends an excellent plan as a model, and in some articles in the "Sanitary Engineer," in 1883–4, he gives a novel plan of a small hospital of two circular wards, just built at Greenwich, which it was thought would be the first circular hospital ever opened for the reception of patients. The plans for very small cottage-hospitals, recommended by Dr. Derby in the report of the Massachusetts State Board of Health, for 1874, are worthy of attention.

Convalescent-hospitals are coming into more common use, and are valuable adjuncts for every general hospital. The practical effects of sending convalescing patients from the wards of a town hospital, to spend a few days or weeks in the healthy atmosphere of the country, are most satisfactory, shortening the illness, making the recovery more complete, and permitting the patients' earlier and safer return to their work. In the annual report of the Massachusetts General Hospital, for 1880, are plans of an excellent convalescent-hospital, and Mr. Burdett's model plan is well adapted for the same purpose.

PREPARATION OF MILITARY SURGEONS FOR FIELD DUTIES; APPARATUS REQUIRED; AMBULANCES; DUTIES IN THE FIELD.

BY

BENNETT A. CLEMENTS, M.D.,

BREVET LIEUTENANT-COLONEL AND SURGEON, U. S. ARMY.

In 1861, the United States of America suddenly entered upon a great war, almost wholly unprepared by experience or training for the novel and responsible duties that it entailed. During its progress, millions of money and many hundreds of lives were sacrificed to ignorance and inexperience. Before it was concluded, there had been developed a system of administration and a completeness of knowledge in the art of military administration that left but little to be desired.

Twenty years have since passed, and the men who learned practically the great lessons of that war are themselves passing away, and the duties which they performed will in the future devolve on a new generation, for "Perpetual Peace is a Dream," and, however much we may cherish the hope that our country may in the future escape the calamities of war, "no man," as General Sherman has said, "is wise enough to foretell when soldiers may be in demand again."

All experience teaches nations to be prepared for war, and never was the inculcation of this lesson more necessary than at present. The changes made of late years and now in progress in the art of war make prior preparation indispensable. We have in very recent years seen an army of a million of men brought from their barracks and homes, and concentrated on a distant theatre of war, in the short period of two weeks; and one of the mightiest of modern European wars was begun and ended in the brief space of six weeks. Whilst the conditions of European warfare may not exist in full degree in our own country, yet the modern and increasing facilities for rapid transportation would render the concentration of large bodies of troops on our northern frontier in a short time entirely feasible. Nor is it useless to regard as possible the occurrence of riots or insurrection in our larger cities, which would equally demand prior preparation of troops for their speedy and efficient suppression. It will therefore be apparent that every administrative branch of our armies should be provided beforehand with at least the knowledge of the means and methods of conducting its operations; and especially is this necessary in the medical department, where the great mass of surgeons must be taken from civil life, and without experience in their new duties.

It will be the purpose of this article to present to the inexperienced medical officer such instructions, and to supply such practical information, as will serve to guide him at the outset of his career, and enable him to avoid the great difficulties and expensive errors that have occurred in the past, to lessen his own personal labors and anxieties, and to secure the proper care and comfort of the sick and wounded committed to his charge.

The military surgeon has daily presented to him on a large scale the highest problems of sanitation, of surgery, and of medicine. Observing the action of special causes on the health of large numbers of men subjected to the simultaneous operation of the same influences, his efforts at prevention or cure, while tested to the utmost, are followed by speedy and easily perceived results, which tend to increase his confidence in the resources of his knowledge, and to ennoble and dignify the practice of his profession, as well as to encourage him to further exertions to lessen the distresses and losses of war.

The roll of men who have left imperishable names as military surgeons embraces some of the most illustrious of the medical profession in both hemispheres, and the young surgeon may well feel pride in applying the resources of their experience to the relief of men who are fighting for the defence and honor of their country.

Discipline.—Every branch of an army must be subject to discipline, which term embraces the prompt and systematic performance of duty, and implicit and conscientious obedience to orders and instructions. The medical officer should be impressed with the fact that he is bound in honor, by his commission, to obey promptly and in good faith all orders and instructions which he may receive, even if their object is not perceived. Without this prompt obedience, his superiors cannot know of the condition of his command or department, and hence cannot make the necessary provision for them. One of the greatest drawbacks to the efficiency of the medical department of our armies, in the earlier days of the war, was the lack of discipline and military training in its officers. Surgeon Charles Tripler, then Medical Director of the Army of the Potomac, says, "In so vast an establishment, . . . without a rigid adherence to system nothing could have been accomplished. It would have been impossible to supply it or know whether it was supplied or not. Now, this system was derisively known as 'red tape,' . . . and medical men fresh from civil life, who ought to have been learners, were encouraged to assert a practical independence of it as a work of a strong will." No evil was more serious, and none can be more destructive to the efficiency of the medical department and the welfare of the army, and it is, therefore, earnestly enjoined on all who may have in the future to act without previous military training as surgeons to an army, to heed the great lesson taught by experience, that *prompt obedience* and *strict fidelity* to duty are the first duties of a military surgeon. By exercising these qualities great results are easily achieved; and the personal exertions of the surgeon accomplish prompt results in the speedy and efficient care of the wounded and sick. So important, indeed, are these military qualities, that without them any system of administration will fail, and Pirogoff, the great Russian surgeon, says, "After all, the fate of the wounded depends more on the *administration* than upon the medical man," an opinion concurred in by Surgeon-General Roth of the German army.[1]

The medical history of our armies in the late war amply demonstrates the truth of these remarks; and the absolute necessity of timely preparation for war is still further emphasized by the changes that have since taken place, and are still in progress, in the methods and material of war. In addition to the speedy concentration on the theatre of war of immense bodies of men, already adverted to, there is added the destructiveness of modern firearms, as a result of which great numbers of men are wounded in an almost incredibly short time; thus at St. Privat, in the Franco-Prussian war of 1870, five thousand men were wounded in fifteen minutes; and at the assault by Grant on the enemy's lines at Cold Harbor, in 1864, over ten thousand men were wounded (besides the killed), the greater part in ten minutes, and all in an hour's time.[1] Under such circumstances every resource of the medical department is brought into instant requisition, and must be at hand. It is, therefore, no useless generality or routine advice to urge upon each medical officer to prepare himself as fully as possible for the great responsibilities which he is called on to bear.

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[1] Trans. Internat. Med. Congress. London, 1881.

It may not be amiss to call to mind here, as a matter of personal interest to the young medical officer, that the so-called hardships of war are not in a well-disciplined army constantly in operation. They consist for the most part only of the deprivation of accustomed comforts and luxuries, which are unnecessary, and even incompatible with the best military spirit.

The humane spirit of his profession should actuate the military surgeon to render to wounded men of the enemy who may fall under his care the same services that he gives to the wounded of his own army. "There are no enemies within our sphere of action," says Longmore. An enemy is no longer an enemy when disabled. Such is the advance made in recent times by the charitable spirit of the century, called into effect by the persistent efforts of military surgeons.

EXAMINATION OF MEN FOR ENLISTMENT.[2]—One of the first duties that the surgeon may be called on to perform is the medical examination of men for enlistment as soldiers; a duty the proper performance of which is of primary importance, and most far-reaching in its results. The great expense, and the injury to the service in all ways that the enlistment of men unfitted for war by physical infirmities causes, cannot well be overrated. Such men encumber the movements of troops, require the care of surgeons and attendants, and the use of an ambulance, and altogether are worse than useless.

It is indisputable that extreme care in the selection of its material was one of the causes of the early invincibility of the Roman armies.[3] A Roman writer has said, "An army raised without due regard to choice of recruits was never yet made a good army by any length of service."

The haste and rapidity with which troops were raised in the early part of our late civil war, and the general inexperience, resulted in a most careless and inefficient mode of examination, and the expense as well as the impaired effectiveness of the troops was enormously increased. It is to be hoped and expected that should it again become necessary to raise large numbers of troops, the importance of a careful medical inspection of each man may not be overlooked, however great may be the apparent necessity for rapid enlistment.

The regulations of the U. S. Army, and the instructions governing enlistment, prescribe in much detail the disqualifying injuries and diseases. Considering that, in all probability, the medical officer called on at the outbreak of a war by the State authorities will have but slight experience in this direction, it is advisedly suggested that at first, and until he shall have acquired some experience, he shall be guided only by the comprehensive General Regulations of 1881, paragraph 785, which are as follows:—

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[1] See Swinton's Army of the Potomac, pages 483-485.

[2] These instructions and suggestions are intended for officers who may be newly called to duty as military surgeons, and are not designed for those who may be charged with the higher administrative duties of the medical department.

[3] Med. Statistics, Provost Marshal General's Bureau, vol. i.

In passing a recruit, the medical officer is to examine him stripped; to see that he has free use of all his limbs; that his chest is ample; that his hearing, speech, and vision are perfect; that he has no tumors, or ulcerated or extensively cicatrized legs; no rupture or chronic cutaneous affection; that he has not received any contusion or wound of the head that may impair his faculties; that he is not a drunkard; is not subject to convulsions; and has no infectious disorder, nor any other that may unfit him for military service.

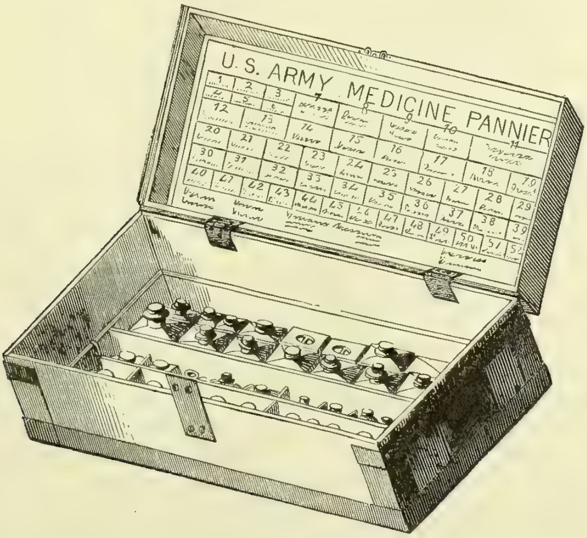
The "Manuals" of Tripler and of Bartholow, now in use in the army as standard authorities, may be consulted in doubtful cases, and the surgeon should speedily familiarize himself with their details. Much detailed information, with abundant illustration, may be found in the first volume of the "Medical Statistics of the Provost Marshal General's Bureau," 1875, but this important subject cannot be considered further here.

Medical Equipment for a Regiment.—Having now selected the men who are to compose his regiment, or having been assigned to a regiment without having had a part in the selection of its individual members, the medical officer has to procure the material and appliances for the care of the sick and wounded of his command.

It is the most common error of the new army surgeon to procure, or to deem necessary, too great a supply of medicines and other material. It is important to make requisition for only the smallest amount that is really necessary, in order to limit the amount of transportation. The question has been exhaustively considered in all its details, and, as the result of accumulated experience, a list of medicines, instruments, dressings, etc., has been prepared by the Medical Department of the army, which is known as the "standard supply table," and of which the last edition was issued in 1883.

Until the regiment reaches the field of military operations, the following articles may answer the current wants for sickness and wounds:—

Fig. 1527.

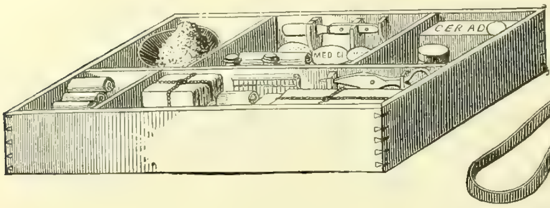

U. S. ARMY MEDICINE PANNIER

Medicine-pannier.

1. A *medicine-pannier* (Figs. 1527, 1528), of which there is a standard pattern, and a list of the contents of which is given on page 25 of the "supply table." This pannier is conveniently arranged, and should be accessible at all times.

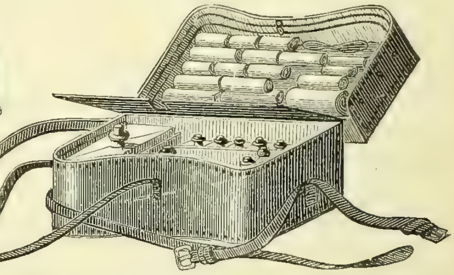
2. *A medicine-case* (Fig. 1529). This is a small case to be carried on the person of either the surgeon or his hospital steward, containing a few of the more commonly needed medicines, with brandy, chloroform, bandages, and dressings.

Fig. 1528.



Upper tray of medicine-pannier.

Fig. 1529.



Coolidge's medicine-case or field-companion.

3. It will be advisable for the surgeon to procure some additional articles, such as antiseptic dressings and plaster of Paris, with crinoline, or "serim," for making plaster splints. These should be carried in a small box with a hinged lid.

4. *A field-case of instruments*, a list of which will be found on page 23 of the "supply table."

5. *A pocket-case of instruments.*

6. *A mess-chest*, containing cooking apparatus and table furniture for twelve men. A list of contents of such a chest is given on page 29 of the "supply table" above mentioned.

7. And the following additional articles, viz :—

20 blankets in two separate cases.
2 hospital tents, adapted to shelter eight men each.
6 bedsacks, empty.
1 wall tent, } for dispensary and office.
1 table with folding legs, } for dispensary and office.
1 small desk, } for dispensary and office.
1 axe, 2 spades, 2 buckets.
4 large rubber blankets.
3 lanterns.
2 ambulances, with 2 litters each.[1]

This equipment will suffice for a regiment of ten companies, until it joins an army; or for independent service, as in case of riot or insurrection in cities. The officials charged with the raising of troops should be prepared to furnish the foregoing articles, requisition being made upon them by the regimental surgeon.

In reference to service in the case of riot, it may be hoped that the commander of the troops will show such prompt and merciful severity as will speedily quell it. The medical officer may then assume that his services will be limited to giving the first aid to his wounded, by primary dressings, temporary splints, etc. He should previously have requested that a few men should be placed under his orders for the purpose of removing the wounded to some secure spot which he has selected for the purpose, whence after dressing their wounds they can be removed to the nearest hospitals. In selecting such a place, it will be best for the surgeon to avoid using churches or theatres, but he should select a large hall, unencumbered with pews or permanent seats, and in such a location as he may have reason to think is safe from assaults or exposure to the fire of the rioters. On his recommendation, the commanding officer of the troops should seize express wagons or other convenient vehicles, with which the wounded may be removed to the nearest hospitals without injury.[1]

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[1] See Figs. 1530–1534, pp. 1129, 1130, *infra.*

The regiment having reached the seat of actual war, becomes at once a part of the great machine—the army—and the medical officer like all others will find his acts now subordinated to the will of superiors. His responsibilities are distinct and well defined, and by an article of war cannot be delegated to others.[2]

As the same supervision of the hygiene of his regiment is required of the surgeon in an army as when it is acting separately, the general subject will here receive brief attention.

Hygiene of Camps and Sanitary Care of Troops.—The limits prescribed for this article will not admit of a detailed consideration of this important subject, but some general observations and special injunctions will be given, which it is thought will be practically useful. The late Surgeon Jonathan Letterman, to whom we are indebted for the organization of the Medical Department of the Army of the Potomac, wrote as follows:[3]—

> A corps of medical officers was not established solely for the purpose of attending the wounded and sick; the proper treatment of these sufferers is certainly a matter of very great importance and is an imperative duty, but the labors of medical officers cover a more extended field. The leading idea which should be constantly kept in view, is to strengthen the hands of the commanding general by keeping his army in the most vigorous health, thus rendering it in the highest degree efficient for enduring fatigue and privation, and for fighting. In this view, the duties of such a corps are of vital importance to the success of an army, and commanders seldom appreciate the full effect of their proper fulfilment. Medical officers should possess a thorough knowledge of the powers and capabilities of the human system; the effect of food, raiment, and climate, with all its multiplied vicissitudes, the influences for evil which surround an army, and the means necessary to combat them successfully. It is the interest of the government, aside from all motives of humanity, to bestow the greatest possible care upon its wounded and sick, and to use every means to preserve the health of those who are well, since the greater will be the number for duty; and the more attention bestowed upon the sick and wounded, the more speedily will they be able to perform the duties for which they were employed. When medical officers consider this subject attentively, all their high and important duties will naturally occur to them.[4]

Bearing in mind these views of his duty, the great value of which cannot be questioned, the medical officer may be guided as to many practical details in caring for the health of his regiment by the following circular of Medical Director Letterman, issued to the Army of the Potomac, May 12, 1863:—

> In the selection of camping grounds, that should be selected which has natural drainage, and all low-lying and bottom-lands, and lands in the vicinity of stagnant water, should be avoided. Every camp should be thoroughly ditched by main ditches, eighteen inches deep, and the ground around the tents drained by ditches leading into the main ditches of the camp.
>
> Camps should, whenever possible, be pitched in the vicinity of running streams, or of living springs, and the use of surface water, or that from holes dug two or three feet in the ground, should by all means be avoided. Camps should not be formed in the woods,

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[1] It would be advisable that the medical equipment above detailed, should be provided and kept on hand at each regimental armory in our large cities. The tents, axes, and desk should be omitted. There should be one or more ambulance wagons, provided with hand litters, held subject to order in the vicinity of the armory.

[2] See page 1141, *infra*.

[3] Medical Recollections of the Army of the Potomac, p. 100.

[4] In the late war, the deaths from disease were double the number of those "killed in battle" and "died of wounds" combined.

but upon the open ground, where a full and free exposure to the sun and air can be obtained, and the tents should be pitched upon the ground, and in no case should the men be permitted to excavate the earth underneath them, nor should the distance between the tents be less than that required by the Regulations. The tents should be struck twice a week, and the ground over which they have been pitched be exposed to the direct rays of the sun and to the winds, and, if possible, they should be placed upon new ground, if only a few feet distant, once a week. The troops should be required to procure the small boughs from the pine-tree and spread them thickly upon the ground covered by the tents, and should renew them once a week; these will keep them from sleeping on the ground, which they should not be permitted to do. The cooking, especially when in camp, should be done by companies, and not by individuals or by squads, and for this purpose two men should be detailed from each company as cooks, one relieved every month, thus allowing each one detailed to be on this duty for two months.

The importance of police, general and special, cannot be too highly regarded. The blankets and bedding of the men should be removed from the tents and exposed to the sun and air daily, when the weather will permit. Every tent, and the ground in and about and between the camps, should be thoroughly policed daily, and all refuse matter, or filth of whatever kind, be buried at least three feet under ground; and all dead animals, and all offal and blood from slaughtered animals, should be at once buried at least four feet beneath the surface, and the refuse matters from stables and wagon-yards should be buried two feet under ground, or burned.

In every camp sinks should be dug and used, and the men on no consideration be allowed to commit any nuisance anywhere within the limits of this army. The sinks should be eight feet deep, if the ground will permit, and have earth to the depth of six inches thrown in every evening, and when filled to within three feet of the surface, be entirely filled up with earth, and new ones dug. No one thing produces a more deleterious effect upon the health than the emanations from the human body, especially when in process of decay; and this one item of police should receive especial attention. Holes should be dug near each company kitchen, in which should be cast all the refuse matter from it, and when filled to within two feet of the surface, should be filled with earth and new ones dug.[1]

The men should be required to wear their hair cut short, bathe twice a week, and put on clean underclothing at least once a week. The troops should have their breakfast as soon as they rise.

Spasmodic efforts, in a matter of such paramount importance as police in an army, can be of no service, and I recommend that regimental and other commanders be required to see that these suggestions, if they meet the approval of the commanding general, be fully and continuously carried into effect.

It was made the duty of corps commanders and other independent commanders of troops, and of officers of the inspector-general's department, to enforce a compliance with the foregoing instructions, and the effect of their observance was speedily shown in the vigor and good health of the army.

Whilst these details are designed for the police and sanitary care of more permanent camps, they should also govern in principle the temporary camps, where the troops remain for two or several days.

On marches, the medical officer may render great service to new troops by advising that the men be ordered to bathe their feet after each day's march when it is at all practicable; to encourage them to drink sparingly of water while on the march, and to omit no opportunity of refilling their canteens, a precaution that every careful commander will be glad to take. Attention to these details will save the strength of any command.

On transport vessels, the guiding thought of the surgeon should be to keep the vessel *dry*, *clean*, and *ventilated*, and to enforce personal cleanliness among the men by daily ablutions at stated times, and by the airing of their blankets on deck when the weather will permit.

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[1] It is better, as subsequent experience proved, to have barrels for this purpose, with a general sink as a receptacle at a distance.

In all his duties relating to the sanitary care of troops, the medical officer's position is now well defined,[1] and he is officially recognized as a sanitary officer whose recommendations, if not concurred in by his immediate commander, must be submitted to higher authority. It will, however, seldom occur that a judicious recommendation of measures for preserving or improving the health of troops will not be willingly adopted. Among these measures one of the most important will be the issue of fresh bread and fresh or preserved vegetables. The medical officer should also frequently inspect the cooking of the regiment, and see to it that the cooking is not done by squads or individuals, as was so often the case early in the late war, but by companies. He may be of great service in this particular, for the great destroyer of armies is diarrhœa caused mainly by bad or improperly cooked food. A useful guide to the proper preparation of the soldier's ration, together with many simple devices for field-cooking, may be found in the small work, "Manual for Army Cooks," published by authority of the Secretary of War in 1883.

The following directions for cooking in camp were published to the Army of the Potomac in 1862, at the instance of Surgeon Letterman, U. S. A., Medical Director. They are eminently practical, and will prove of the highest utility:—

Directions for Cooking in Camp.

The importance of soup as a diet for troops is not sufficiently apprehended except by veteran soldiers, those of experience in the field. It cannot be too highly esteemed, and should be used to a much greater extent than it is. Bean soup, when properly made, is one of the best that can be used; when improperly made, one of the worst. The beans must be washed, steeped in water over night, put on the fire at reveille, and boiled slowly for six hours; a piece of pork, say one ration for three men, put in three hours before dinner; this, eaten with a little pepper and vinegar, makes a wholesome and palatable dish. The cooking is everything; if not well done, it is positively injurious; if well done, it is wholesome. The great principle in making soup is that it must be boiled slowly and for a long time; it cannot be boiled too much. In making beef soup all the bones should be used, together with half rations of beef, rice, and desiccated and fresh vegetables, with salt and pepper; the desiccated vegetables should be steeped in water for two hours, and boiled with the soup for three hours; the rice should be added, after having been washed, half an hour before the soup is served; the beef must first be put in cold water, and the soup kept at a low boil for five hours. Beef should not in any case be used for cooking until cold. Hard bread will be more palatable and more easy of digestion if placed in the ashes until thoroughly heated; it can also be improved by breaking it in pieces an inch or two square and soaking it thoroughly in warm water, then placing it in a frying pan with a few slices of pork, and cooking for five minutes, stirring it, that all may be cooked alike. Such portions of beef as are not used in making soup should be cut in pieces about the size of a hen's egg, and, with half a ration of potatoes and a small-sized onion cut in slices, to one man, and half a ration of desiccated vegetables previously soaked in cold water for an hour, with a few small pieces of pork, adding salt and pepper, with water sufficient to cover well the ingredients, and stewed slowly for three hours, will make an excellent dish. Beef that is not used thus should be cooked on coals or held before them on a stick or fork, and no salt or pepper put on until cooked; the salt put on before cooking only assists in abstracting the juices of the meat, and in making it dry and hard when cooked. The secret in using the desiccated vegetables is in having them thoroughly cooked. The want of this has given rise to a prejudice against them which is unfounded; it is the fault of the cooking, and not of the vegetables. Pork should be boiled three hours, having been previously soaked in water, to abstract the salt, for three hours, the water being changed twice in that time; when cold and cut in slices, with a piece of bread and a slice of onion, it makes an excellent lunch; cut in slices and toasted over coals, it is sweet and good. Coffee should be roasted over a slow fire, constantly stirring it until it becomes of a chestnut-brown color, and not burnt as is so commonly done. It should be boiled for twenty minutes, set on one side, sweetened, well stirred, and a little cold water added to cause the grounds to settle. Cabbage is more wholesome when cut in shreds and eaten with a little vinegar, pepper, and salt, than when cooked. All fried meats are unwholesome; they should be boiled or broiled.

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[1] See General Order 125, War Department, A. G. O., Nov. 17, 1874; and Paragraph 2315, Army Regulations, 1881.

The foregoing instructions relate mainly to the duties in *general* of all medical officers. Before giving the specific duties of each grade of medical officer in an army, a brief outline is here presented of the *medical organization of an army in the field*, taking for illustration that of the Army of the Potomac, which reached so high a degree of efficiency, and of which there remain the most complete records.

An *army corps* consists of divisions, brigades, and regiments. To each corps there is a "medical director;" to each of the three or more divisions of a corps, a "surgeon-in-chief;" to each of the three or more brigades composing the division, an officer of similar title; and to each regiment forming the brigade, three surgeons. The *division* is the working unit of organization of the medical department, and is provided with an equipment of ambulances, wagons, tents, supplies, and men for establishing a field hospital.

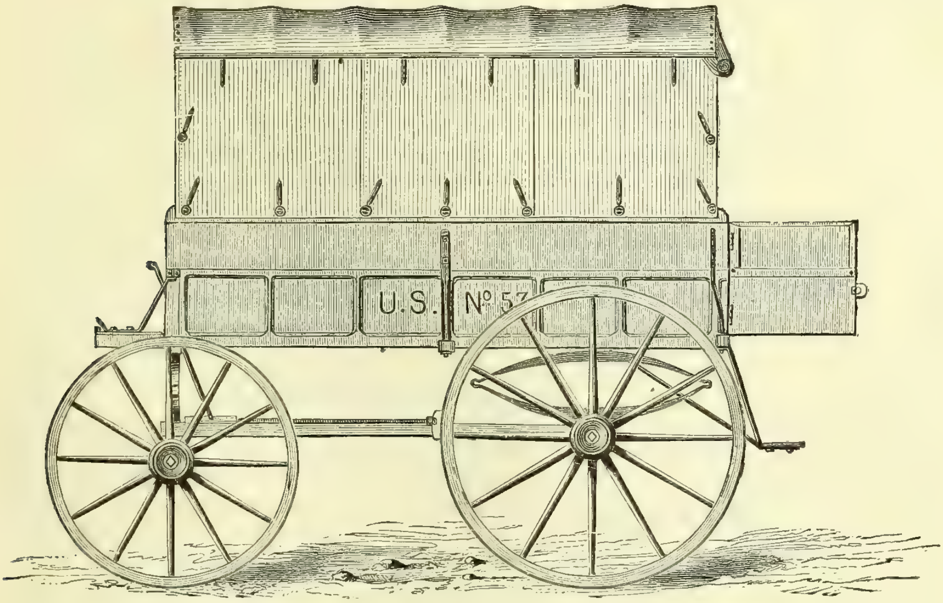
The following table will show at a glance the medical equipment of the first division of each of the army corps of the Army of the Potomac on the opening of the Wilderness campaign in May, 1864. The army was then in the highest condition of discipline and organization, and the material carried was at its minimum.

HOSPITAL ORGANIZATION, ARMY OF THE POTOMAC, AT THE BEGINNING OF THE "WILDERNESS" CAMPAIGN, MAY, 1864.

ARMY CORPS.	Division.	No. of brigade.	No. of Regiment.	No. of men.	No. of hospital tents.	No. of army wagons.	No. of medicine wagons.	No. of ambulances.
Second	1st	4	21	8000	22	14	4	59
Fifth	1st	3	21	8100	25	14	3	57
Sixth	1st	4	17	8000	24	17	4	48

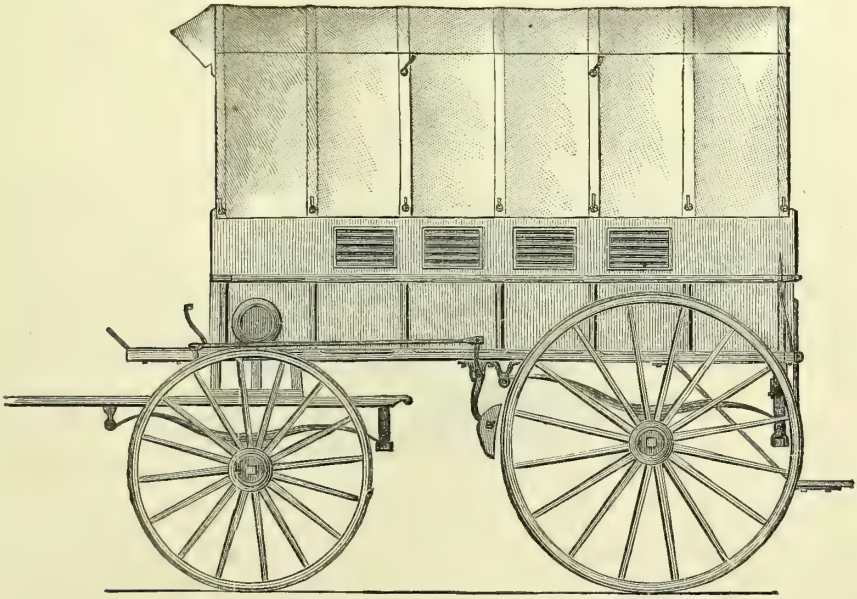
AMBULANCE CORPS.—The ambulance corps was instituted in accordance with the plan of Surgeon Jonathan Letterman, U. S. A., in 1862, and was enacted into a law by Act of Congress, approved March, 1864. It consists of ambulance-wagons (Figs. 1530, 1531, 1532)—commonly with us in America designated as "ambulances"—of the necessary men and animals, of medicine-wagons and army wagons, and the tents (Fig. 1534) and other quartermaster's material used in the field hospitals. A captain of the line, under the medical director, is the commander of the ambulances of the army corps, and to each division there is a lieutenant of the line who commands and is responsible for the division ambulances; he is the acting assistant quartermaster of the division ambulance corps, and is responsible for all the material and the tents and other quartermaster's property used for the field hospitals. By this very practical and convenient arrangement the medical officer is relieved from much care, and is enabled to give his whole attention to the wounded and sick. The number of ambulances and men varies with the number and strength of the regiments, the details of which may be found in the Act of Congress above cited.

Fig. 1530.



Wheeling or Rosecrans ambulance-wagon.

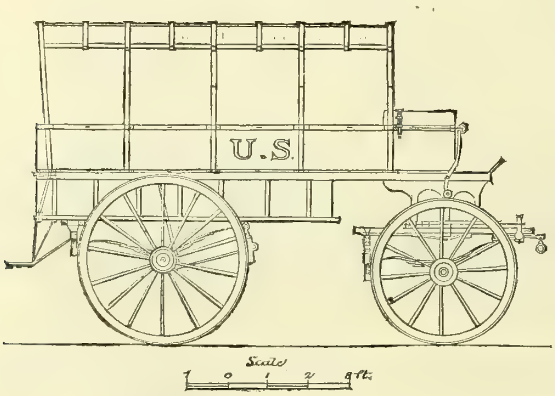
Fig. 1531.



Tucker ambulance-wagon.

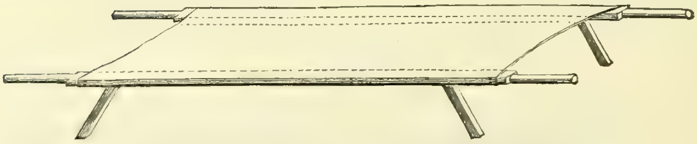
Field Hospitals.—The system of field hospitals, the operations of which were so satisfactory in the campaigns of the Army of the Potomac, was devised by Surgeon Jonathan Letterman and promulgated in a circular dated October 30, 1862. As the provisions of this order remained in force until the end of the war, and were never materially departed from, it is here given in full:—

Fig. 1532.



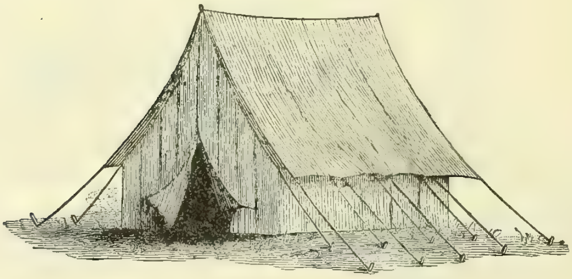
New army ambulance-wagon, approved by the Secretary of War, 1881.

Fig. 1533.



Halstead's hand-litter.

Fig. 1534.



Regulation hospital-tent.

HEAD-QUARTERS, ARMY OF THE POTOMAC,
MEDICAL DIRECTOR'S OFFICE, October 30, 1862.

SIR: In order that the wounded may receive the most prompt and efficient attention during and after an engagement, and that the necessary operations may be performed by the most skilful and responsible surgeons at the earliest moment, the following instructions are issued for the guidance of the medical staff of this army, and medical directors of corps will see that they are promptly carried into effect.

Previous to an engagement there will be established in each corps an hospital for each division, the position of which will be selected by the medical director of the corps.

The organization of the hospital will be as follows:—

1st. A surgeon in charge, one assistant-surgeon, to provide food and shelter, etc.; one assistant-surgeon to keep the records.

2d. Three medical officers to perform operations; three medical officers, as assistants to each of these officers.

3d. Additional medical officers, hospital stewards, nurses of the division.

The surgeon in charge will have general superintendence, and be responsible to the surgeon-in-chief of the division for the proper administration of the hospital. The surgeon-in-chief of division will detail one assistant-surgeon, who will report to and be under the immediate orders of the surgeon in charge, whose duties shall be to pitch the hospital tents, and provide straw, fuel, water, blankets, etc., and, when houses are used, to put them in proper order for the reception of the wounded. This assistant-surgeon will, when the foregoing shall have been accomplished, at once organize a kitchen, using for this purpose the hospital mess chests and the kettles, tins, etc., in the ambulances. The supplies of beef stock and bread in the ambulances, and of arrowroot, tea, etc., in the hospital wagon, will enable him to prepare quickly a sufficient quantity of palatable and nourishing food. All the cooks, and such of the hospital stewards and nurses as may be necessary, will be placed under his orders for these purposes.

He will detail another assistant-surgeon, whose duty it shall be to keep a complete record of every case brought to the hospital, giving the name, rank, company, and regiment, the seat and character of injury, the treatment, the operation, if any be performed, and the result, which will be transmitted to the medical director of the corps, and by him sent to this office.

This officer will also see to the proper interment of those who die, and that the grave is marked with a headboard, with the name, rank, company, and regiment legibly inscribed upon it.

He will make out two "tabular statements of wounded," which the surgeon-in-chief of division will transmit, within thirty-six hours after a battle, one to this office (by a special messenger, if necessary) and the other to the medical director of the corps to which the hospital belongs.

There will be selected from the division, by the surgeon-in-chief, under the direction of the medical director of the corps, three medical officers, who will be the operating staff of the hospital, upon whom will rest the immediate responsibility of the performance of all important operations. In all doubtful cases they will consult together, and a majority of them shall decide upon the expediency and character of the operation. These officers will be selected from the division without regard to rank, but *solely* on account of their known prudence, judgment, and skill. The surgeon-in-chief of the division is enjoined to be especially careful in the selection of these officers, choosing only those who have distinguished themselves for surgical skill, sound judgment, and conscientious regard for the highest interests of the wounded.

There will be detailed three medical officers to act as assistants to each one of these officers, who will report to him and act entirely under his direction. It is suggested that one of these assistants be selected to administer the anæsthetic. Each operating surgeon will be provided with an excellent table from the hospital wagon, and, with the present organization for field hospitals, it is hoped that the confusion and the delay in performing the necessary operations, so often existing after a battle, will be avoided, and all operations hereafter be *primary*.

The remaining medical officers of the division, except one to each regiment, will be ordered to the hospitals to act as dressers and assistants generally. Those who follow the regiments to the field will establish themselves, each one at a temporary depot, at such a distance or situation in the rear of his regiment as will insure safety to the wounded, where they will give such aid as is immediately required; and they are here reminded that, whilst no personal consideration should interfere with their duty to the wounded, the grave responsibilities resting upon them render any unnecessary exposure improper.

The surgeon-in-chief of the division will exercise general supervision, under the medical director of the corps, over the medical affairs in his division. He will see that the officers are faithful in the performance of their duties in the hospital and upon the field, and that by the ambulance corps, which has heretofore been so efficient, the wounded are removed from the field carefully and with despatch.

Whenever his duties permit, he will give his professional services at the hospital—will order to the hospital, as soon as located, all the hospital wagons of the brigades, the hospital tents and furniture, and all the hospital stewards and nurses. He will notify the captain commanding the ambulance corps, or if this be impracticable, the first lieutenant-commanding the division ambulances, of the location of the hospital.

No medical officer will leave the position to which he shall have been assigned without permission; and any officer so doing will be reported to the medical director of the corps, who will report the facts to this office.

The medical directors of corps will apply to their commanders on the eve of a battle, for the necessary guard and men for fatigue duty. This guard will be particularly careful that no stragglers be allowed about the hospitals, using the food and comforts prepared for the wounded. No wounded will be sent away from any of these hospitals without authority from this office.

Previous to an engagement a detail will be made, by medical directors of corps, of a proper number of medical officers, who will, should a retreat be found necessary, remain and take care of the wounded. This detail, medical directors will request the corps commanders to announce in orders.

The skilful attention shown by the medical officers of this army to the wounded upon the battle-fields of South Mountain, Crampton's Gap, and Antietam, under trying circumstances, gives the assurance that, with this organization, the medical staff of the army of the Potomac can with confidence be relied upon, under all emergencies, to take charge of the wounded intrusted to its care.

Very respectfully,
Your obedient servant,
(Signed) Jona. Letterman,
Medical Director.

Mode of Supply of Medicine and Medical Material.—Medical supplies are obtained by the surgeon-in-chief of brigades from the principal depot, on requisition approved by the corps medical director. He has a "medicine-wagon" (Fig. 1535), a vehicle especially fitted up for the convenient arrangement and dispensing of the medicines, dressings, etc., and also one or more army wagons to transport such supplies as are in bulk. He issues his supplies to the regimental surgeons as they are needed to fill up their "field companions" and "panniers," and is responsible that the amounts are at all times kept up to the standard prescribed.[1]

It will be observed that the ambulance service, the field hospital service, and the mode of supply, are but harmoniously working parts of one system, which may be comprehensively designated as field hospitals for both wounded and sick. The system is very simple and practical in its working, and any officer of average acquirements will easily master all its details. A vast experience gained in the late war in all our armies proved its adaptation to the utmost needs of the service, and its essential features will probably be adopted in any war that may occur during the lifetime of men now living.[2]

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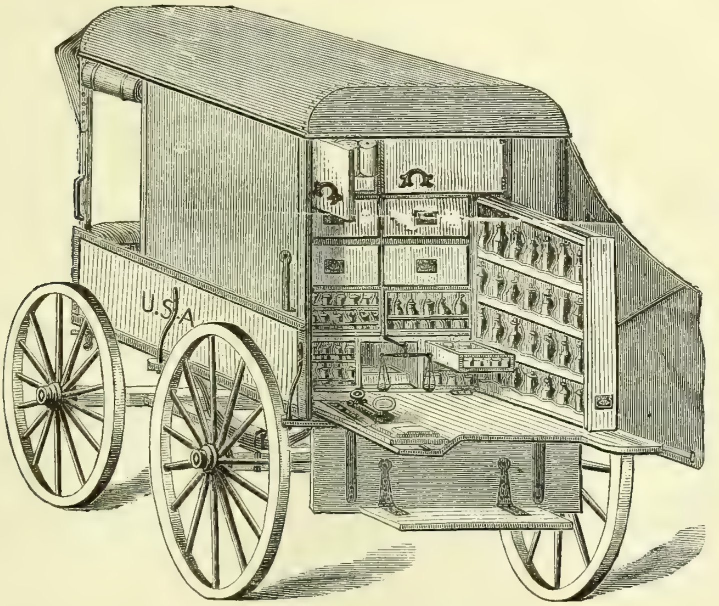
[1] For the amounts and kinds of medicines, dressings, etc., see the "Standard Supply Table of the Medical Department, U. S. Army, 1883."

[2] Dr. Jonathan Letterman, who devised this plan of medical administration, was born in Pennsylvania, December 11, 1824. He graduated in medicine at Jefferson College, Philadelphia,

The foregoing general remarks and considerations will, it is hoped, enable the reader to better understand the account that will now be given of the specific duties which devolve upon each grade of medical officers in an army in the field. In 1864, Surgeon T. A. McParlin, U. S. A., then the medical director of the Army of the Potomac, caused to be drawn up a detailed account of the duties of each class of medical officers in that army. These accounts were written by experienced men then actually engaged in the performance of the duties referred to. They are of the very highest value, a value indeed that will be appreciated only by those who know through what labor and suffering the medical department of the army was developed to the great excellence that it had attained at the time that these papers were written.

Fig. 1535.



Autenreith medicine-wagon.

The profession and the army are indebted to the wise forethought of Surgeon (now Brevet Brigadier-General) McParlin for them, and it is a subject of congratulation that they can in this place be given a wider circulation among the surgeons of to-day, and be more accessible in the future. They are here reprinted from the "Medical and Surgical History of the War of the Rebellion," Part Third, Surgical Volume, pp. 903–914. The writers belonged to

in 1849, and in the same year entered the U. S. Army as Assistant-Surgeon. In June, 1862, whilst still in this grade with only the rank of captain, he was made medical director of the Army of the Potomac, and joined it immediately after its repulse from before Richmond. The army had sustained great losses in men and material. The measures that he speedily adopted for the better organization and reëquipment of its medical department were attended with great success. His ambulance system was adopted by Congress ; his plan of field hospitals was adopted by the Surgeon-General for all the U. S. Armies, and continued to be used until the end of the war, and its originality and excellence have been freely admitted by the highest military authorities in Europe. He enjoyed the entire confidence of every Commander of the Army of the Potomac. He resigned from the army in December, 1864, and died in San Francisco, California, in March, 1872. For a further account of his services the reader may consult a "Memoir" of his life in the "Journal of the Military Service Institution of the U. S.," for September, 1883, and his own work, "Medical Recollections of the Army of the Potomac."

the fifth army corps, of which Surgeon (now Brevet Brigadier-General) J. J. Milhau was so long the medical director, and which was noted for the precision and thoroughness of its work.

Duties of the Medical Director of a Corps.—The medical director of a corps is the head of the medical and ambulance departments of the corps, and he is held responsible by the corps commander that they shall be properly and effectively managed under all circumstances. It is therefore impossible to specify definitely his duties in every case. He should possess the confidence of his commander, and ask for instruction in all cases of doubt. He should have an office, and at least two clerks, of whom one should be a hospital steward. The following books should be kept, viz.: 1st. A register of all medical officers and regular hospital stewards belonging to the corps; 2d. An endorsement book; 3d. A letter and order book; 4th. A blotter, in which are checked off the regular requisitions, and monthly reports of sick and wounded as received; 5th. A manifold writer. The following regular reports are received: 1st. Daily report of the medical inspector of the corps; 2d. The weekly report of sick and wounded; 3d. The weekly report of the ambulance corps (in duplicate); 4th. The weekly report of brandy and whiskey received, issued, etc., from each brigade and from each hospital; 5th. The monthly returns of medical officers from divisions and brigades; 6th. The monthly returns of hospital stewards U. S. A.; 7th. The monthly returns of ambulance officers (in duplicate); 8th. Statement of hospital fund from each hospital. After engagements are to be transmitted to the medical director of the army: 1st. Nominal lists of wounded for transmittal; 2d. Classified returns of injuries and wounds (in duplicate); 3d. Aggregate mean strength of command (per regiment); a report of the operations of the ambulance corps. The following consolidated reports for the corps are made at stated periods to the medical director of the army: 1st. Weekly report of sick and wounded; 2d. Monthly return of medical officers; 3d. Monthly return of hospital stewards U. S. A.; 4th. Statement of balance due hospital fund; 5th. Record of certificates of disability, and action thereon. All other reports are simply transmitted without consolidation.

The following papers are referred, by order of the corps commander, to the medical director for approval, recommendation, expression of opinion, or disapproval, viz.: All tenders of resignation on account of disability; all applications for leave of absence; all certificates of disability for discharge, and invalid rolls when doubtful; all recommendations and complaints referring to the medical and ambulance departments, or affecting the health and well-being of the troops; all applications for leave of absence or resignation of medical or ambulance officers—in fact, all papers relating to the medical department are referred to the medical director prior to the action of the general commanding. The following papers require to be examined and acted upon by the medical director: All requisitions for medical and hospital supplies, and all requisitions and estimates for supplies for the ambulance corps. Written circulars and instructions from the medical director of the army and from the surgeon-general should either in whole or part be promptly published to the surgeons-in-chief of divisions and surgeons-in-chief of separate commands. The health and welfare of the troops, as well as the comfort and proper care of the sick and wounded, should receive the unceasing attention of the medical director. It therefore becomes his duty to ascertain, through the medical inspector and the surgeons-in-chief of divisions, and from his own observation, the existence of irregularities and of deficiencies in the hospitals or in the command, and he must issue the necessary instructions to have the one corrected and the other supplied. In matters of defective police, bad drainage, unhealthy camp grounds, insufficient shelter, improper or damaged food, etc., he should first call the attention of the medical officers to the fact and suggest remedies; but if these suggestions be not promptly attended to, a written report with recommendations should be made without delay to the corps commander. Special attention must be given to the keeping up of supplies, both medical and hospital. Circulars should be issued from time to time, giving information to the medical officers as to what articles can be obtained, and specifying the manner of obtaining them.

The ambulance corps being under the direction of the medical director, the ambulances and everything connected with them claim a full share of his attention. In conjunction with the chief ambulance officer he must therefore see that nothing is neglected to render them efficient in every respect, and that the intention of the law is carried out. The surgeons-in-chief of divisions look to the medical director for orders, instructions, and suggestions in reference to the fitting up of the different hospitals; he should therefore instruct them as to the number of tents to be pitched, and as to whether it is desirable to construct fire-places, erect bunks, dig wells, etc. etc. As a general rule, verbal orders will be sufficient. When a movement is ordered, the medical director should ask for instructions in reference to the sending off of sick and wounded, the breaking up of hospitals, and the number of ambulances and wagons allowed to march with the troops and the number to be sent to the rear, and on receiving them will give the necessary orders in writing, specifying the number of tents and flies to be carried, as well as the amount of hospital supplies, medical stores, clothing, and rations, and directing the surgeons-in-chief of divisions to see that the "hard bread" is put up in the ambulance boxes, and that the field companions and hospital knapsacks are filled. Orders should be given to the chief ambulance officer in reference to the position of the stretcher-bearers; as a general rule they should all march with their commands, with stretchers. When only a limited number of ambulances accompany the troops, all the stretchers should go to the front strapped on the ambulances. Orders should be given to have the water-kegs filled.

On the march, the medical director accompanies the staff, acquainting himself as far as practicable with the nature of the country passed over, the general direction and condition of the roads, the position of the houses, streams, woods, etc. etc. This knowledge will materially assist him in the selection of hospital sites. When an engagement commences, the medical director should ascertain the position of the troops, and should immediately communicate with the surgeons-in-chief of divisions, directing the establishment of field depots for the wounded at such points as will be most convenient for collecting them, and where the ambulances can come up. In locating these depots, special care must be taken to have them as near the line of troops as possible, so as to diminish the distance of stretcher transportation. Ravines and woods should be taken advantage of as a protection against the enemy's fire; if necessary, a breastwork can be thrown up by the attendants. An occasional bullet or an occasional shell is not sufficient to warrant medical officers in leaving their posts. If practicable, the medical director should himself visit and inspect these depots, and give orders that will insure the object of their establishment; he should also consult with the chief ambulance officer as to the best roads, everything considered, to be taken by the ambulances. Should the enemy fall back, these depots should be removed farther to the front; should our own troops yield the ground, the depots must be moved farther to the rear. The moment the number of wounded warrants the establishment of division hospitals, the corps commander should be consulted as to the locality of these hospitals in a military point of view. The medical director then selects the site himself, or designates some one to do it in his name. Orders should be immediately given to the surgeons-in-chief of divisions, and to the chief ambulance officer, designating the locality chosen. Should a lull occur in the firing, or the enemy be driven back, orders must be immediately given to advance the field depots and to take all the available ambulances to the front, so as to pick up the wounded as rapidly as possible and convey them to the hospitals.

During an engagement, the duty devolving upon the medical director of a corps to select a site for the different hospitals of the corps is not always an easy one. As a general rule, they should be placed near the most practicable roads, in rear of the centre of the troops, and sufficiently to the rear to be out of the ordinary range of the enemy's guns; suitable ground, good water, and plenty of fuel must of course decide the choice of locality. During the action, the medical director must keep himself thoroughly acquainted with the movements of the troops, and must act accordingly. The corps may take up a new position with a different front; sometimes a part or even the whole of a corps may meet a superior force and be repulsed; under such circumstances the medical director should be ready to act promptly, and to transfer his wounded to a safer locality. Should the corps commander be present, he will advise his medical director of the state of affairs, and give orders in reference to the removal of the hospitals. There are times, however, in which the medical director is called upon to act upon his own responsibility. Should it become necessary to leave the wounded in hospitals in the hands of the enemy, the medical director will see that they are properly sheltered, that a sufficient number of medical officers, hospital stewards, and attendants remain with them, and that an ample supply of medical and hospital stores, dressings, and provisions be left for their comfort.

After an engagement, the medical director of the army should be communicated with as to the means of transportation for the wounded to general hospital; he should be informed of the number, and of the time at which they will be ready for such transit; on receiving instructions, the necessary orders are given. The medical inspector generally attends to the shipment of wounded. During action, the duties of a medical director require his presence at corps headquarters, where he can be found, and where he can obtain the earliest information and receive orders and reports. As a general rule, therefore, he cannot stop to operate during an engagement; he should remember that he is responsible for all the wounded, and that there are occasions in which the delay of half an hour will result in the loss of his hospitals. The corps commander should be kept informed of the operations of the department both during and after engagements, and should always be consulted in matters of importance. As it is necessary for the medical director to visit his hospitals and field depots from time to time, he should always leave a competent medical officer at headquarters to represent him. When practicable, the hospitals of the different divisions should be located near together—each one, however, to be kept perfectly independent and distinct in its management. This will much facilitate the operations of the ambulance and medical departments, enabling the divisions to assist each other in taking care of the wounded. For instance, should one division suffer more than another, an operating staff, or more if necessary, with an Autenrieth wagon, can be ordered to the suffering division; again, should one division be deficient in shelter or supplies, they can be obtained from the other divisions; another advantage is the facility given for inspection, and for giving instruction, and in distributing the wounded as they come in; for instance, all available ambulances are used when wanted, without reference to their divisions. An ambulance reaches the hospital containing wounded of different divisions; no difficulty is experienced in distributing them, each to his own division hospital, thus enabling them to be treated by their own medical officers and to be registered in their own divisions. Again, in sending off the wounded to general hospital, the loading of the wagons will be much facilitated, and a corps train readily found. When avoidable, the wounded should not be sent off from the field division hospital until they have been operated upon, properly dressed and fed, have obtained some rest, and have somewhat recovered from the shock of their injuries.

In sending sick and wounded off to general hospital, the corps director gives the necessary orders to have the wagons or cars properly bedded with brush or hay, specifies the number of rations to be taken, and the number of medical officers, stewards, and attendants that should accompany the train, giving any instructions that he may deem important in reference to the roads, camping, etc. When the troops remain in camp some time, it will be found convenient to have near each division a few ambulances, with horses hitched up ready to convey patients to the hospital. These are known in the corps as picket ambulances, and are relieved every twelve hours. At this post there should be a medicine-wagon, under the charge of a steward, to issue medicines to the regimental surgeons. The post should be marked by an ambulance guidon; this wagon is to be relieved as often as emptied. As a large number of stretchers and lanterns are always broken or lost during an engagement, orders should be given after an action to have the deficiencies supplied as early as possible.

Duties of the Medical Inspector of a Corps.—A medical inspector of a corps has but few specific duties assigned to him, and these, with one exception, are such as the medical director may direct to facilitate the management of the medical department, and to keep him informed of the deficiencies which need correcting, and of errors that should be rectified; as his relative position to the medical director is analogous to that occupied by an assistant adjutant-general to his commanding general, any authority he may exercise in the discharge of duty is entirely delegated power. The only reports made to him are the daily morning reports of each hospital from which the corps report is made. A monthly report of the inspection of troops has been used; but since that has been abandoned, reports, not in tabular form, have been made of the condition of the troops only to the medical director, calling his attention to any violation of sanitary rules that may have been observed. Previous to an engagement, or march, he sees that the direction of his superior officers relative to the proper disposition of the flying hospital and medicine-wagons are obeyed, and that they are in readiness to accompany the troops. The principal duty devolved upon him during an engagement has been to represent the medical director at the hospitals, to see that the men are properly provided for, and, when instructed to send wounded to the rear, to assist the chief ambulance officer in the proper apportioning of the means of transportation, to make the detail of medical officers and attendants to accompany the train, and to ascertain that they are provided with stimulants and other essentials to render the patients confided to them as comfortable as possible.

Duties of the Surgeon-in-Chief of a Division.—1. The surgeon-in-chief of a division promulgates to surgeons-in-chief of brigades all orders, circulars, and communications that are received from the medical director of the corps, also all orders, circulars, and communications pertaining to the medical department that emanate from division headquarters. 2. He receives all reports that are made by the surgeons-in-chief of brigades, and consolidates them before forwarding them to the medical director of the corps, except the "monthly report of sick and wounded" furnished by the regimental surgeons, and the weekly report of "brandy and whiskey" furnished by the surgeons-in-chief of brigades; these are forwarded without any action from him. The only reports made directly by him are the "monthly return of medical officers" of the division, which he forwards to the medical director of the corps, and the personal report to the Surgeon-General from the post at which he is serving. 3. All requisitions for medicines and hospital supplies, made by the surgeons-in-chief of brigades, are received by him and forwarded to the medical director of the corps, without any action from him, except "special requisitions," which are either approved or disapproved before being forwarded. 4. All applications for leave of absence and resignation on surgeon's certificate, and all certificates of disability for discharge of enlisted men, are forwarded from their regiments through the regular military channel and referred to the surgeon-in-chief of the division by the assistant adjutant-general of the division; each case is personally examined by the surgeon-in-chief, and his action indorsed on the official paper. Applications for leave of absence of medical officers are referred to the surgeon-in-chief by the assistant adjutant-general, for his action. 5. All details of medical officers and enlisted men for duty at division hospitals are made by the assistant adjutant-general, to whom the names, rank, regiment, and company, are furnished by the surgeon-in-chief. 6. The surgeon-in-chief of a division has no official relation with any staff officers except the assistant adjutant-general. 7. A detail of one medical officer as "officer of the day" is made each day by the surgeon-in-chief, with instructions to visit each regiment of the division and inspect carefully its hygienic and sanitary conditions, also to visit the division hospital and see that proper attention is given to cleanliness and to the comfort of the patients; to examine the cooking and see whether the attendants perform their duties faithfully. A written report is to be furnished of these investigations. 8. Before an engagement, the detail for the "field hospital" is announced by the surgeon-in-chief of the division; the surgeon in charge of the division hospital remains in charge and has control of all the shelter; the officer detailed as hospital commissary provides the food; the records are kept by a hospital steward, U. S. A. Three surgeons are detailed as operators, and three medical officers are assigned to each operator as assistants. One cook, two nurses, and one hospital steward are taken from each regiment for the "field hospital." 9. The medical officers who remain on the field at the time of and after an engagement are instructed to form their depots and locate them by brigades, and are to select their positions in compliance with instructions of "circular" from headquarters, army of the Potomac, medical director's office, dated October 30, 1862,[1] and to examine each man before he is put in an ambulance. 10. The position of a surgeon-in-chief of a division during an engagement is, first to locate the "field hospital" and see that the details are properly filled; then to visit the front and confer with the ambulance officer of the division, ascertain that the depots are properly located and that the ambulance sergeants have been notified of their positions, and then report to the general commanding and receive any instructions he may have; afterwards to return to the hospital and assist in making the wounded comfortable. 11. On the march, the surgeon-in-chief of a division remains with the general commanding.

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[1] See page 1131, *supra.*

Duties of a Surgeon-in-Chief of a Brigade.—(1) The surgeon-in-chief of a brigade has under his charge all the medical supplies allowed to his command. He draws once a month, from the medical purveyor of the army, all that is needed to bring what he has on hand up to the requirements of the supply table, and in case of emergency can, during the month, make special requisitions for necessary articles. He issues to medical officers in charge of regiments only what they want for immediate use. By this excellent arrangement the army has been relieved from the encumbrance of the large supplies formerly allowed to regiments, and the transportation of the medical department is greatly reduced. Under two orders from Surgeon Letterman, Medical Director of the Army of the Potomac, brigade surgeons were forbidden, for more than a year, to take receipts from regimental surgeons for supplies issued to them, and the brigade surgeon was ordered to expend them on his annual returns. This proving unsatisfactory to the Treasury Department, a circular from the Surgeon-General directed a return to the requirements of army regulations in the transfer of all property. As medicines and other expendable articles are issued continuously, and in very small quantities, it is unavoidable for the surgeon-in-chief of a brigade to be forced to expend, on his returns, much property really issued to regimental surgeons. In addition to the articles carried in the wagons, the boxes of the ambulances are filled with the material necessary to establish a temporary field hospital in case the supply train during a movement should be inaccessible. This arrangement is one of the greatest advances made during the past two years in providing for the wounded, as the conveyances bringing them in have all that is absolutely required to feed them, and the hospital tent-fly generally carried in the ambulance gives sufficient shelter. In the construction of new ambulances, it would be desirable to increase the width and depth of the box so that larger camp kettles could be carried, the present only admitting the smallest sized kettle.[1] The surgeon-in-chief of a brigade furnishes the material carried in the ambulance-boxes, and assures himself by weekly inspections of them that each box contains all required by the supply table and other orders. He also draws from the medical purveyor, and is responsible for, the stretchers carried on the ambulances.

(2) The surgeon-in-chief of a brigade is the medical adviser of a brigade commander in all professional questions affecting the command. Applications for leave of absence, discharge, and invalid rolls, grounded on the certificates of regimental surgeons, are submitted to him for his opinion of their propriety, to be based on an examination of the applicant. It is the duty of the surgeon-in-chief of a brigade also to keep careful watch over the health of the brigade, pointing out and endeavoring to correct all infractions of hygienic laws. He receives every Saturday, from each medical officer in charge of the regiments constituting the brigade, a weekly report of sick and wounded of his regiment, and of the anti-scorbutics issued to it. Whenever a regimental medical officer leaves or returns to his command, he should furnish the surgeon-in-chief of the brigade with a copy of the order under which he acts. The surgeon-in-chief consolidates the regimental weekly reports of sick and wounded, and of anti-scorbutics, and forwards them to the surgeon-in-chief of his division. He sends, at the same time, a report of the liquors drawn and issued by him during the week. He makes also, to the surgeon-in-chief of the division, a monthly return of the medical officers of the brigade. After a battle, he sends to the surgeon-in-chief of the division a report of the aggregate strength for duty and names of medical officers present for duty, and the killed, wounded, and missing in action, according to the reports received from regimental surgeons. The losses in skirmishing in the intervals between the battles have been reported weekly.[2]

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[1] In the new army ambulance-wagon, approved by the Secretary of War in 1881, valuable space in the box under the driver's seat is taken up by a water keg. It also weighs several hundred pounds more than the old and tried "Wheeling ambulance." (See Fig. 1532, page 1130, *supra.*)

[2] The brigade surgeons should not be selected, as a rule, for the operating surgeons of the division field hospitals, as their presence is necessary at the depots nearest the line of battle to exercise supervision over the medical officers there stationed.

Duties of the Surgeon in Charge of a Division Hospital.—The duties of a surgeon in charge of a division hospital are somewhat varied, depending upon the season of the year and the state of military operations, whether the army is in winter-quarters or engaged in an active campaign. In one case, more permanent arrangements are made with a view of remaining undisturbed for several months; in the other, all the appliances of a division hospital are arranged and managed to meet certain conditions, definite transportation, general mobility, and despatch in its construction and removal. Procuring all the necessary supplies for the sick and wounded, superintending the care and treatment which they should receive, organizing the hospital attendants, keeping the necessary and suitable records, causing reports to be made, and receiving orders from his superior officers and complying with them, are briefly, in the aggregate, the duties of the surgeon in charge of a division hospital. On the march, the sick and wounded on hand are placed in ambulances, and a medical officer, connected with the hospital, is assigned the duty of keeping with the ambulance train and rendering such assistance on the journey as the wants of the sick, etc., may demand. In the evening, or at the close of the day's march, the surgeon in charge will make the necessary arrangements for sheltering and furnishing the sick, etc., present with food and medical attendance. This is often accomplished in this manner: The medical director of the corps indicates to the ambulance officer the place he desires the ambulances to park. The surgeon in charge then proceeds to pitch a certain number of tents, directs the cooks to provide beef-tea, hot coffee, etc., orders sinks to be dug, and sees that the sick and wounded are unloaded and taken care of, thus affording them attentions and comfort consistent with the nature of circumstances. On the following morning, after food has been served to all, a "sick-call" is held, and all that require medicine receive it. Soon after, a morning report is made, signed by the surgeon in charge, and sent to the surgeon-in-chief of the division. Thereafter, if it is intended to resume the march, the sick and wounded are reloaded, the tents are struck, and everything packed. Thus the routine continues from day to day, as long as the march may last.

In the event of an engagement, the surgeon-in-chief of the division indicates to the surgeon in charge of the hospital the place selected for the location of the division hospital. The latter then directs the pioneers or fatigue party to police the ground and pitch the tents, establishes the kitchen, appoints a chief cook and a cook for special diet, organizes the nurses and other attendants, unloads the ambulances of the sick, provides operating tables, and all necessary appliances for surgical operations, such as chloroform, stimulants, dressings, etc., orders sinks dug, sees that a sufficient supply of water is near, either by opening springs or by digging wells, etc. Thus accommodations are made for the sick on hand as well as for the wounded that may be brought in from the battle-field. The surgeon in charge selects a medical officer to superintend unloading and disposing of the wounded as they come in. Such as require operations are taken to the tables and receive the attention of the surgeons. Very often comfortable and convenient beds are made by filling sacks with hay or straw, raising them from the ground on crutches or cross-pieces. The Recorder's attention is then called to the wounded, and he takes down their names, rank, regiment, and character of injury, and, in order to prevent confusion, often finds it necessary to attach a small piece of bandage to the button-hole of the wounded man, that he may be assured afterwards that his name, etc., has been registered. It is the duty of the surgeon in charge to see that the reports at the operating tables are properly kept, specimens preserved and labelled,[1] etc. He selects either a medical officer or a hospital steward to have immediate supervision of the kitchen, diet, and feeding of the men. He sees also that the wounds of all the wounded men are examined and dressed, and, in order to secure this, a sufficient number of medical officers are assigned to wards as dressers, and a medical officer, surgeon or assistant surgeon, is appointed each day to act as officer of the day. He is required to be on duty at night also, to attend to any emergency that may arise—sudden hemorrhage, prostration, etc. The dead likewise require the duties of the surgeon in charge. He selects a suitable location for a cemetery, and here inters the dead, giving them a Christian burial by the presence of a chaplain to officiate and attend to the funeral obsequies. The graves are marked by a head-board, written or inscribed on which are the name, rank, company, and regiment of the deceased. His effects are preserved, and at a convenient time disposed of according to the requirements of the army regulations.

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[1] A large metal can, or covered close-stool, was provided for this purpose. The number designating the specimen, and attached to it, may be written on a piece of smooth wood or parchment with a *pencil.*

The surgeon's duties consist, likewise, in making out provision returns and drawing from the commissary of subsistence a sufficient number of rations for the sick and wounded, as well as for the hospital attendants present. He should see to it that an abundant supply of chloroform, stimulants, beef-stock, blankets, bed-sacks, bandages, dressings, shirts, drawers, and socks is on hand to meet almost any emergency that may occur. When the sick and wounded are ordered to be sent to the "depot hospital," a list of them will be made out complete, which, when approved by the medical director of the corps, will be sent with the medical officer who accompanies them. A proper entry of the disposition of these will be made in the register. The supervision of the hospital-fund made from the savings devolves upon the surgeon in charge. He will keep a correct account of it, and authorize the purchase from it of such delicacies as are needed for the comfort of the more serious cases in the hospital. The surgeon in charge of the hospital is immediately subject to the orders of the surgeon-in-chief of the division, and to such other orders as may come through him from higher authority —medical director of corps and army. His reports should be made through the same channel, also his requisitions for medical supplies, requests for details, etc., and in fact all communications whatever, except property returns, which go directly to the department of the Surgeon-General. The following is a list of reports, requisitions, etc., made by the surgeon in charge of the hospital: A weekly report, monthly report, report of sick and wounded, certificates of death, requisitions for medical and hospital stores, morning reports, etc. The following is a list of the books and registers kept on hand: Morning report book, register, prescription book, case book, letter and order book.

Duties of the Medical Recorder of a Division Hospital.—(1) During a battle the names of all wounded admitted to the hospital are carefully entered in the prescribed forms: Lists of wounded, giving rank, company, regiment and corps; also the nature of the missile or weapon causing the injury, when wounded, its nature (slight or severe), and the treatment pursued in each case. On this form are also entered all amputations and other operations, and deaths. After an engagement is over, a classified return of wounds and injuries is prepared from this list. (2) At the operating table an assistant prepares all specimens of interest for preservation in a specimen jar. Here, likewise, the name and designation of the patient is noted down, with a full detail of the injury and the operation performed, with the name and rank of the operator. When the specimen is ready to be deposited in the jar, it is labelled, and the number on the label written opposite the patient's name. As soon as possible afterwards, a complete list is made of all the operations, during the engagement, giving, as it were, a history of each case, the number opposite the patient's name corresponding with the number of the specimen in the jar. After a battle, a report of aggregate strength of men and names of medical officers present for duty is also made out.

Duties of the Attending or Prescribing Surgeon of a Division Hospital.—1. To visit his ward regularly twice each day, or as often as the condition of his patients may require. 2. To examine and make proper diagnosis of patients as they may be reported to him, either for wounds or disease; to make and keep a correct register of all patients, with their treatment, and daily to report them to the surgeon in charge of the hospital. 3. To prescribe suitable remedies and to see that they are regularly administered by the attendants. 4. To inspect the diet of the men and see that proper food is given them. 5. To attend strictly to the sanitary condition of his ward and surroundings, and compel those whose duty it may be to remove everything offensive or detrimental to health. 6. To assist in all surgical operations, or operate, as he may be required by the surgeon assigned to that duty. 7. To see that the men under his care are as comfortable as circumstances will admit.

Duties of the Operating Surgeon.—1. The operating surgeon shall select steady and reliable attendants, give them clear and explicit instructions relative to their respective duties, and assign to each his proper place. 2. He shall see that all the necessary appliances are at hand, required in performing operative surgery, that the instruments are in good order and in their proper places, and that a good and sufficient supply of lint, bandages, ligatures, sponges, plaster, etc., is conveniently placed and ready for use. 3. He shall take charge of all patients that in the opinion of the prescribing surgeon require surgical attention, make a minute and thorough examination of each case and determine whether surgical aid is necessary; judge of the best manner of benefiting the patient, taking into consideration the relation of important organs, vessels, and nerves, in proximity to the wound, what bearing they may have in the preservation or loss of the patient's life, and to use every preservative means within the reach of surgical science to save the life of the patient with as little impairment of all his functions as possible.

Duties of the Regimental Surgeon.—The first duty of the day is that of the morning "sick-call," when the sick and disabled, as well as those who are neither sick nor disabled, present themselves for treatment. The surgeon is called upon to exercise his judgment in determining the character and gravity of their ailments. If he had none to deal with but those who were really sick, his task would be plain, simple, and easy; but, unfortunately, many of the cases are feigned, and he is required to discover and overcome the means brought into requisition by a skulker's ingenuity to carry out his deception. Presuming that the surgeon is fortified by skill and experience sufficient to detect these, and has a just sense of responsibility to the United States Government (for he really regulates the strength of the command), his examinations will be made without partiality, and regardless of position or prejudice, and in his report he will assign to duty those who are fit for duty, the sick to quarters for treatment, or send them to hospital, and recommend the permanently disabled for discharge or the Veteran Reserve Corps. It may be added that in cases having slight symptoms of diseased action, insufficient to indicate positive and unmistakable disease, humanity would dictate, and authority sanctions, that they be placed off duty, and that they may have the benefit of the doubt, and time for development of disease. Having concluded his work thus far, the surgeon will see that a copy of his report is forwarded to the adjutant, who deducts all excused from duty from the mean strength present in the regiment, and the available strength of the command is obtained, which forms the basis for all details and assignments that may be made in the regiment. Should the regiment be filled up by conscripts, substitutes, or enlisted men, the surgeon is required to examine each one carefully and report on his fitness for service, rejecting all those who, by reason of infirmity, are unfit, and recommending for reception such as he thinks will be able to discharge the duties of a soldier.

That the duties imposed upon the surgeon are important, is obvious to any one, and should be particularly so to an officer who has recorded his obligation to subserve the interest of the United States. If the surgeon indulges the men and reports them off duty, when they are not sick, he imposes additional labor on the faithful men, who bear the heat and burden of the day, and virtually offers a reward to the faithless; or if in examining recruits he admits any who are physically disqualified, he acts in bad faith to all, and in the end unwarrantably weakens the command, defrauds the government, and may be the cause of rendering an important engagement abortive. If he conducts his examinations carelessly, the men will soon avail themselves of the chance to escape duty, and in great numbers report themselves sick; the surgeon loses his influence for good, and he sinks into disrepute and merited disgrace, which do not terminate with his service in the army, but will follow him throughout all time. After "sick-call," the surgeon should visit the sick in quarters, prescribe for them, and see that suitable food is provided and their quarters made as comfortable as possible; should inspect the camp daily, see that it is well drained by proper ditching through which all superfluous or surface water may be carried off, that all filth or anything likely to produce disease is removed or corrected, that the quarters of the men are swept and aired, and their bedding exposed to the sun whenever practicable, that the sinks are covered with dirt, that the food of the men is of good quality and sufficient quantity (reporting any error in either), and that the cooking is judiciously done. These duties are essential and should receive daily attention, as the neglect thereof will decidedly increase the sickness of the regiment and consequently impair its efficiency. Should a soldier die in camp, or in regimental hospital, the surgeon should notify his commanding officer and forward to him an inventory of the soldier's effects, with a record of the disease from which he died and the date of his death; and should select a place for his burial, and see that he is decently buried, and his grave carefully marked. The duties thus far pointed out are obligatory, and no excuse can be made for their non-performance in camp. There are many other acts of kindness, more correctly denominated "favors," that can be extended by a surgeon without detriment to himself, that will have a good effect upon the soldier in leading him to believe that his life and comfort command the surgeon's consideration; these being done willingly, will have the effect of improving the morals of the command and the usefulness of the surgeon.

When a march is likely to be made, the surgeon is directed to send his sick to general or division hospital. Again he is called upon to make a careful and rigid examination to avoid imposition; for the terrifying effect of a prospective battle will cause men to limp who never limped before, and many hitherto good soldiers will make an effort to escape it. The surgeon completes his list and forwards a copy by name, rank, and company, regiment, and disease, with descriptive lists of each man; when he loads his men, providing sufficient food for the time required to reach the hospital. Having provided the requisite quantity of medicines, etc., to fill the "hospital-knapsack," or "field-companion," he gives them to his hospital attendants, and when the regiment moves, the surgeon, hospital steward, and attendants take their position in the rear. If any of the command take sick or are wounded on the march, the surgeon is notified, and is prepared to prescribe medicines or suitable dressings, and furnishes a pass for ambulance transportation (a duplicate of which he retains), or directs them to walk leisurely in the road, being governed by the severity of the diseases or wounds, and being careful that no deception is practised by men that are not sick, recording each case in his "field-register," with character of disease or wound. Having thus carefully discharged his duties during the day, and though the march has been a long and laborious one, he should, after arriving in camp, visit and prescribe for the sick, and endeavor to make them as comfortable for the night as the means at hand will permit, before his day's work is done. Again, in the morning, before the regiment moves, he should see them and prescribe medicines for the day, select such cases as require wagon transportation, and see that they are loaded, and those able to march started, before he leaves the camp. From day to day these duties should be performed. Although trying on the strength of the surgeon, he should not fail to do them, as, sooner or later, a day of rest will come, and he will be able to recuperate.

During an engagement, the surgeon, if not detailed on the operating staff at the hospital, should report with his assistants and attendants to a point selected in the rear of his command, either by brigade or regiment, and notify the sergeant in charge of the stretcher-bearers thereof, that the wounded may be carried to said point; to whom he should give such medicines and apply such dressings as their wounds may require to afford comparatively comfortable transportation to the hospital of their division, where each case receives minute examination and further attention. Should the surgeon be placed on the operating staff, his duty, in connection with other members, is to examine carefully every wounded man and determine the extent of his wound, the parts involved, and the necessity for and kind of operation his case may demand. Should he be selected to perform the operation, he should endeavor to do it as scientifically and with as much dispatch as the nature of the case and safety of the patient will admit, and in all cases should apply appropriate dressings in such a manner that they will not become detached in transportation to general hospital. He may be thus employed for an indefinite length of time; he should therefore feel it incumbent on him to labor as long as there are any cases requiring attention, until all have had the advantage of primary operations, and are relieved from the excessive pain of undressed wounds and the increased mortality attending secondary operations. The duties of the surgeon in every position may be summed up in one sentence. He does not rest until everything is done that can contribute to the comfort of the wounded. After a battle, the surgeon will report to his regiment unless otherwise ordered, and resume the charge thereof, and will perform such duties as are mentioned in describing those in camp, etc., previously procuring the names of the men killed in the action, and of the wounded, the nature of their wounds and character of the missile inflicting them, together with all statistics required in reports he may have to make.

The reports required of a surgeon of a regiment are the "morning report" to the adjutant, the "weekly" to the surgeon-in-chief of the brigade, and the "monthly." It is altogether necessary that a medical officer should so conduct his department that he may secure the confidence of the officer in command of the regiment to which he is attached, that said officer may receive his reports and rely on their correctness. If both military and medical officers are sincerely interested in the health of the regiment, and act in concert, much can be done to promote order and discipline. The necessity for this can be discovered when the opposite is experienced. The surgeon cannot have an order issued or carried into effect without great difficulty, and if the variance should continue, the intercourse will be so unpleasant that the command eventually suffers in consequence. The officers are mutually responsible and should be mutually respectful.

Duties of the Assistant Regimental Surgeon.—The duties of an assistant surgeon when in charge of a regiment or hospital are identical with those of a surgeon in the same position. If he be acting under a surgeon in charge, he will perform such share of the surgeon's duties in the care of the sick as the surgeon may assign to him. The sick in the ambulances on the march are usually put in charge of an assistant surgeon, one or more, whose duty it is to accompany the ambulances and see that such medicines are administered as the patients may require; usually he both prescribes and dispenses. He decides also what patients must be carried, and when they are well enough to walk or to rejoin their companies. Beef-stock, tea, and sugar, are carried in each ambulance for the use of the sick, subject to the order of the assistant surgeon in charge, and to be prepared by the ambulance-men belonging to each ambulance. When an action is about to take place, the surgeons with the regiments are usually ordered to the division hospital, while the assistant surgeons are left to establish depots, where the wounded come or are brought by the stretcher-bearers to be dressed. A depot of this kind should be in some comparatively safe place, but not too far from the regiment, and where the ambulances can have a good chance to come without being in great danger from the enemy's fire; it should also be convenient to good water, which will be needed for dressing the wounded. If the place is too much exposed, the stretcher-men will not be likely to bring the wounded, nor will wounded men wish to be left where they may get more wounds while being dressed or waiting their turn to be attended to; but will prefer to go further to the rear. If the ambulances cannot come to the depots where the men are brought to be dressed, a sudden change in the lines may cause some men to be left on the field who were waiting to be attended to, and who might have been carried off in a very few moments if necessary, even though they were not dressed, were the ambulances there. Still, although perfectly safe places can seldom be found near where the fighting is going on, especially where the ground is comparatively even, the assistant surgeon should not allow his fears to induce him to remain too far away from his men, and they should be kept advised of his whereabouts; hence, when a regimental field hospital has been established, it should not be moved unless absolutely necessary.

Assistant surgeons on the battle-field should be furnished with the ordinary surgeon's dressing case of instruments—operations requiring other instruments than these are usually of too severe a character to be attempted on the field. He should be accompanied by one or two nurses with plenty of lint, bandages, isinglass plaster, water, sponges, and a few of the most frequently required medicines. After dressing the men, the surgeon should see that they are properly placed in the ambulances, and give the direction for their care until they reach the division hospital—duties often of great importance to the patient. When it can be done conveniently, it is better that the assistant surgeons of several regiments or of a brigade be together on the field, as they will often be enabled to assist and advise each other. An assistant surgeon in the field has very little opportunity for observing severe surgical cases; after the first dressing, he very rarely sees or hears anything of their further treatment or termination.

Duties of the Commissary of Subsistence of a Division Hospital.—The division Hospital Commissary is under the immediate direction of the surgeon in charge of the hospital; he makes reports to him and receives his orders. His duties while in camp are to draw at stated intervals from the commissary officer, authorized to issue to the hospital such stores as are required for the use of the sick and wounded, stewards, and authorized attendants, on provision returns approved by the surgeon in charge. He is required by existing orders to keep on hand at least one thousand rations of bread, sugar, coffee, tea, pork, and from six to ten head of beef-cattle. He makes a daily inspection of the stores on hand in order to keep up the necessary amount of supplies, so as to be ready at all times for a rapid movement or an engagement. It is also his duty to make out the provision returns, having them agree with the morning report of sick and wounded; the names of all the hospital attendants to be written on the back of each return. He superintends the purchase of such articles as are not furnished by the government, and which the surgeon in charge considers necessary for the use of the sick and wounded. He also keeps an account of the savings of the hospital, and makes a monthly report of the state of the hospital fund to the surgeon in charge. He has, in conjunction with a medical officer, charge of the cooking and preparation of the food, seeing that there is no unnecessary waste, and that the place in which the stores are kept and food prepared is properly policed daily. When orders to move are received, he attends to the packing of the supplies in the wagons assigned for that purpose. He also sees that there is a sufficient number of cooking utensils on hand, and that they are kept clean and in good condition. On the march, he is required to keep his wagons with the hospital department, or wherever they may be ordered; also to have the beef-cattle up with the wagons, so that, if necessary, they can be slaughtered and prepared for food in the evening, or whenever a halt is ordered. He selects a proper place for cooking purposes, unloads such stores as are required for the occasion, and, if within reach of the supply train, gets his stock replenished. On the approach of an engagement, it is his duty to have hot coffee, tea, beef-soup, and other necessary articles of diet, ready for the wounded as soon as they may be brought in from the field. When the wounded are being sent to the depot hospital, he furnishes each man with sufficient rations to last him until he reaches his place of destination. When men are returned to duty from the hospital he also furnishes them with rations.

Duties of the Chief Ambulance Officer of the Corps.—In addition to the regular monthly returns of quartermaster's property, the chief ambulance officer of the corps receives and makes the following reports; (1) Daily wagon and forage report; (2) weekly ambulance report; (3) monthly report of transportation; (4) monthly report of officers in quartermaster's department of the ambulance train and the time to which they have made their property returns; (5) monthly report of all quartermaster's property received and issued during the month; (6) monthly report of officers serving in the ambulance train. When not on the march, the chief ambulance officer of the corps inspects the ambulance train every Sunday morning, with the object of correcting all abuses and of promoting the efficiency of the train.[1] Before a move, he should give timely notice to the division ambulance officers, so that they may have everything packed up and ready to start at the appointed hour. It is his duty to regulate the order of march of his train, select suitable camping grounds, and see that his train is at all times ready for active service. Before an engagement, he informs himself as well as possible about the country, roads, etc., and sees that his train is well up and together, so that as soon as the lines of battle are established he can park his whole train in some central position from which to send picket ambulances as near the lines of each division as possible. An officer is always placed in charge of the main park of ambulances, one is in charge of the picket ambulance of each division, and the remainder of the officers are instructed to take charge of the stretchers, men, and sergeants. It is also necessary to leave an officer in charge of the hospital train of the corps. The chief ambulance officer must personally superintend the working of his train so as to see that every one does his duty, that the drivers do not become stampeded, and that the wounded are transferred to the hospital as quickly and easily as possible. It is also his duty to see that the stretcher-men do not carry the wounded farther than is necessary. When in camp, and it is necessary to send off sick or wounded, the chief ambulance officer orders the proper number of ambulances, and details an officer to take charge of the train; one ambulance officer from each division superintends the loading of the ambulances of his division hospital. When in camp, the stretcher-men are used in the hospital when needed. It is also necessary that the chief ambulance officer should see that the ambulances are not improperly used. It being desirable to receive orders as early as possible, the chief ambulance officer finds it best to have his quarters at corps head-quarters.

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[1] He should endeavor to keep his train in as good condition as the best batteries of horse artillery.

Duties of the Chief Ambulance Officer of a Division.—He should be the receipting officer for all quartermaster's property belonging to his division, and be responsible for all deficiencies. He should make all necessary returns required by the quartermaster's department, commissary department, and ordnance department, viz: Monthly returns of property to the quartermaster's department, quarterly return of ordnance, usual ration-return to commissary department, also the daily forage report, the weekly report of ambulance department, monthly report to quartermaster's department, and monthly report of officers. When on the march, he should attend to the running of his train, see that forage is drawn from the nearest post, and a sufficient quantity kept constantly on hand; properly park his train at night according to orders from the chief ambulance officer of the corps, necessary sentries being posted so that horses may not stray away or be stolen, and be ready to move at short notice. Before an engagement, it is his duty to see that the brigade officers are with their brigades, and that they have the sergeants and stretcher-bearers well up with their regiments; to have his train so parked that it will be easy of access, and so near that the stretcher-men will not have any further than actually necessary to carry the wounded, and at the same time protect his horses from unnecessary exposure; and after an engagement to assure himself that all the wounded of the division have been removed from the field; also to assist the surgeon when a train of sick and wounded is to be sent to base or general hospital.

Duties of the Chief Ambulance Officer of a Brigade.—1. While in camp, one brigade officer of each division train is constantly with the troops, and in case of any movement reports the fact at once to the chief ambulance officer of his division. He should see that the drivers and stretcher-men are at the established posts, and that all orders from surgeons for ambulances or stretchers for the transportation of sick or wounded men are promptly attended to. 2. When not on duty with the troops, he will see that the ambulances are properly parked, and that the drivers attend faithfully to the feeding and grooming of their horses, the cleaning of the harness and ambulances, and the policing of the stables and grounds of the park; also that the kegs are kept *constantly* filled with fresh water. Stretcher-men will assist in the policing when not on duty at the division hospital. 3. A suitable non-commissioned officer will be selected to have the direct supervision of the ambulances of the brigade, and another of the stretcher-men. The rest of the non-commissioned officers will have charge of the stretcher-men of their respective regiments under the one in charge of the stretcher-men of the brigade. 4. On the march (unless otherwise directed) brigade officers remain with the headquarters of their brigades, and in case of an engagement select a spot as near the line as possible, with a reasonable degree of safety to the horses, and as central to the lines of the brigade as possible. 5. The brigade officer will cause a small number of ambulances to be brought to the spot selected, and others to be sent to fill their places; and as fast as they are filled will send them to the place selected for the hospital. The stretcher-men will be informed of the position of the ambulances, and will bring to them as fast as possible any man that may be wounded or unable to walk, until all the wounded men are carried from the field. 6. The brigade officer should inform himself of the shortest and best roads to the division hospital, and see that the drivers take them, driving carefully, and avoiding the bad places as much as possible on an uneven road. A good non-commissioned officer should remain constantly with the advanced ambulances to see that the wounded men are loaded carefully and speedily, and that the drivers do not get demoralized. 7. No written reports are made by brigade officers. They report verbally to the division officer any breach of discipline or neglect of duty that may require his attention. 8. He receives only such orders as come through the chief ambulance officer of the corps, or of his division, or through some medical officer.

The space at command will not admit of giving here the various blank forms of reports and returns mentioned in the foregoing account. Some are to be found in the army regulations of 1881, and all will doubtless be supplied when needed by the medical authorities.

The subjects of the transportation of wounded by railroad and by hospital transport-vessels, as well as the organization and management of general hospitals, do not come within the scope of this article.

A HISTORY OF SURGERY.

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THE INTERNATIONAL ENCYCLOPÆDIA is presumed to fairly represent the present advanced state of the noble and useful Art and Science of Surgery. To trace the gradual evolution of this department of the healing art from the earliest period of reliable records to the present century, is the duty assigned to the writer of these pages.

The subject is far too extensive to admit of exhaustive treatment within the circumscribed limits to which the practical character of this work necessarily confines it. Hence, little more than the outlines, or an epitome, of the history of surgery can be attempted, which, for those who have already familiarized themselves with the subject, will fail to contribute much to their acquirements. On the other hand, it is hoped that this sketch will prove both interesting and instructive to students, and to practitioners whose time has not permitted them to engage in medico-historical researches. Should it serve the laudable purpose of stimulating an increased taste for Medical and Surgical History, and at the same time aid the reader by pointing to more ample sources of information relating to this fascinating subject, the cardinal intention of the author will have been fulfilled.

Surgery has no proper history previous to the Hippocratean epoch. There are a few casual references, and interesting fragments still extant, which suggest that the art of surgery existed long anterior to the period when were made the reliable records which have survived the destroying agencies of more than twenty centuries of time.

The Sacred Scriptures furnish us with the earliest mention of any surgical operation. The five books of Moses were written fifteen hundred years before the advent of Christianity. The first operation of circumcision was performed on Abraham, when he was ninety years of age, which was about 1897 years before Christ. Circumcision was done with sharp Ethiopian stones. "Then Zipporah took a sharp stone and cut off the foreskin of her son and cast it at his (Moses) feet." The practice of using sharp stones for circumcision was continued by the Ethiopians at least as late as 1581 of our era. Sharp stones were also used in very ancient times to open the abdomen for the purpose of evisceration, as a preliminary to embalming. Embalming was done in Egypt, and probably elsewhere, by physicians. When Jacob died, "Joseph commanded his servants, the physicians, to embalm him; and the *physicians* embalmed Israel, and the forty days were fulfilled for him, for so are fulfilled the days of those that are embalmed."

It is doubtful that any useful anatomical knowledge could have been obtained by the embalmers. To be sure, they could observe the size, situation, and general appearance of the viscera, but this would be about the extent of what could be thus derived. An examination of the ingenious and methodical application of bandages to the body and limbs of those who were embalmed in the most elaborate and costly manner, furnishes ample evidence that the greatest possible skill and dexterity were attained in this art by the physicians or embalmers in the ancient days of Egypt. No surgeon of the present day can excel, and few can equal, the skill in artistic bandaging to be seen in the finer specimens of Egyptian mummies still preserved in modern museums.

Aside from many wise sanitary laws, and some allusions to the existence of certain diseases, the writings of the Egyptians, Hebrews, Chinese, and even the Grecians, previous to the time of Hippocrates, are utterly barren in facts which possess any interest to the surgeon.

We are informed by Herodotus[1] that the healing art in Egypt was subdivided into numerous specialties in his day, much as it is now becoming in our great modern cities. He says, "Here, each physician applies himself to one disease only, and not more. All places abound in physicians; some for the eyes, others for the head, others for the teeth, others for the parts about the belly, and others for internal diseases."

It is needless in this place to enter upon a serious inquiry into the probable surgical knowledge and alleged skill of Asclepios or Æsculapius. It is reasonable to infer that a real personage bearing this name once existed, that he possessed extraordinary skill in the art of healing, that he transmitted his knowledge to his posterity, that the family became notorious, and that the original master was in time deified and worshipped in temples; that the attendants of these temples combined the offices of the priest and physician—Priest-Physicians—and that with all their craft and quackery there were some real and useful facts obtained, and valuable methods devised, which are very creditable to so remote and crude an age.

The worship of Æsculapius dates back about fifty years before the destruction of Troy, which event occurred nearly twelve hundred years anterior to the birth of Christ. There are several very interesting allusions to the surgical art in the Homeric poems, which indicate no mean knowledge of the art of extracting barbed arrows by incision, the treatment of wounds, the arrest of hemorrhage, etc. It will be remembered that Homer flourished in the ninth century before the Christian era. Machaon and Podalirius, the sons of Æsculapius, were both surgeons, and imbibed the learning and skill of their renowned father, who was claimed to have been the pupil of the mythical Chiron.

> "Of two great *surgeons*, Podalirius stands
> This hour surrounded by the Trojan bands,
> And great Machaon wounded in his tent
> Now wants the succour which so oft he lent."

The extraction of "deadly darts" and "stinging arrows" by incision is thus alluded to:—

> "Patroclus cut the forky steel away,
> And in his hand a bitter root he pressed,
> The wound he washed and styptic juice infused,
> The closing flesh that instant ceased to glow,
> The wound to torture and the blood to flow."
> *Iliad, Book XI.*

The skill and utility of the surgeon were highly appreciated when Homer sang, and ages long before, as the sapient and august Nestor is made to give his royal opinion in the oft-quoted stanza:—

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[1] Historiar. lib. ii. cap. 84.

> "A wise physician skilled our wounds to heal,
> Is more than armies to the public weal."

We are obliged, in passing from the days when Homer sang to the time when Hippocrates wrote, to span a dreary blank of many centuries, during which, whatever may have been learned by direct observation and experience, was entrusted to unreliable oral and traditional communication from age to age; or, if written, to the almost absolutely annihilating hand of time, so that few traces of medical, anatomical, or surgical knowledge have survived this truly dark period in the history of our art.

The advent of Hippocrates, the cotemporary of Socrates, in the fifth century before the birth of Christ (460–350 B. C.) marks an epoch, or, more strictly speaking, commences the first epoch in surgical history. He was born in an auspicious age, the famous age of Pericles, and in a place of great renown. The island of Cos, in the Ægean Sea, can boast of having given birth to Ptolemy Philadelphus, the second of the Greek kings of Egypt; to Ariston, the philosopher; to Apelles, the famous painter; and to Hippocrates, the great physician. One of the most celebrated of all the temples of Æsculapius, existing at the time of Hippocrates's birth, stood upon this island. This temple, or *asclepion*, like those of Rhodes and Cnidos, was among the noblest and most imposing examples of Grecian architecture, ornate in detail, adorned with impressive colossal statues of the presiding deity of the temples of health—Æsculapius, and his daughters Hygeia and Panacea. On its lofty walls were hung the masterpieces of Apelles—an equestrian portrait in profile of Antigonus, and the Venus Anadyomene, or Venus rising from the sea and wringing her hair with her fingers—priceless pictures, which were held in admiration for many centuries. Hippocrates was well instructed in the polite literature and philosophy of his age by distinguished teachers, among whom were Gorgias and Democritus, the latter himself a student of comparative anatomy and physiology, if not also of medicine in general. He was of the family of the Asclepiadæ, and, as a matter of course, thoroughly initiated into the rudiments, arts, and mysteries of this great school of medicine and surgery. From the clinical teachings of the priest-doctors in attendance at this famous hospital or sanitarium, from the ample records of cases upon its columns and on its votive tablets, together with his own careful observations of the phenomena of disease and the effects of curative agencies in modifying the same, a genius, such as Hippocrates certainly was, could scarcely fail to become master of his profession. The distinguishing characteristics of Hippocrates consisted in his exalted conception of the duties of the physician, as seen in his celebrated "*Oath*," and in various passages among his writings, wherein it will be observed that he was equally free from the frauds of priestcraft and from the debasing quackery of medical charlatans. In the first section of "*The Law*" he says, "medicine is of all the arts the most noble; but, owing to the ignorance of those who practise it, and of those who, inconsiderately, form a judgment of them, it is at present far below all the other arts." He explains this condition of things as being due to a want of law for the punishment of malpractice. "Their mistake appears to me to arise principally from this, that in the cities there is no punishment connected with the practice of medicine (and with it alone) except disgrace, and that does not hurt those who are familiar with it. Such persons are like the figures which are introduced in tragedies, for as they have the shape, and dress, and personal appearance of an actor, but are not actors, so also physicians are many in title but very few in reality."

He regarded diseases as processes which were governed entirely by natural laws and amenable to rational treatment; and not as a direct result of offended gods or the malevolence of demons, which ills were only to be cured by prayers, sacrifices, miracles, and other supernatural influences. Most of all, the splendid example which "the Father of Medicine" furnished to the world, consisted in his careful and minute observation and accurate interpretation of the symptoms of disease, in his simple, methodical, and truthful descriptions of what he had seen, and in his lucid statement of the rational deductions he had made. It would be unreasonable to expect that his writings should be entirely free from error, or his interpretations from dogma. The *humoral* pathology, the doctrines of *crudities*, *coction*, and *crises*, were among the cardinal theories of Hippocratic medicine. Before proceeding to point out any of the surgical observations of Hippocrates, it should be stated that surgery had a literature previous to the time in which he flourished, though, unfortunately, unknown to us except through the occasional and brief references to earlier writers which we find in the works of this author.

Hippocrates is no less entitled to the distinction of being called the Father of Surgery, than to the universal and undisputed rank of being styled the "Father of Medicine." No less than eight of the seventeen treatises now admitted to be his *genuine* works are strictly surgical. They embrace the consideration of many important subjects; and, though not constituting a complete system of surgery, they nevertheless furnish us a very clear insight of the principles and practice of this science and art as it was understood twenty-three centuries ago.

These treatises vary in length and in completeness of finish. They include the following subjects, and are thus entitled: Injuries of the Head; On things relating to the Surgery; On Fractures; On the Articulations; Mochlicus; On Ulcers; On Fistulæ; On Hemorrhoids. The *aphorisms* are divided into seven sections. Section I. has 25; Sect. II. 54; Sect. III. 31; Sect. IV. 83; Sect. V. 72; Sect. VI. 60; Sect. VII. 87; in all 412, of which a considerable number, scattered through the sections, are *surgical* aphorisms. The following are selected to show the character of these brief formulations of his conclusions. "Convulsions or tetanus, coming upon severe burning, is bad." (Sect. VII. Aph. 13.) "Stupor or delirium from a blow on the head is bad." (Sect. VII. Aph. 14.) "In cases of concussion of the brain produced by any cause, the patients necessarily lose their speech." (Sect. VII. Aph. 58.) "In persons affected with chronic disease of the hip-joint, if the bone protrude from its socket, the limb becomes wasted and maimed, unless the part be cauterized." (Sect. VI. Aph. 60.)

When we reflect upon the character and importance of the numerous operations which were then performed, we certainly find more occasion for admiration than we do for adverse criticism. Thus we find that, in the ancient days of surgery, fractures and dislocations were carefully adjusted and reduced; extension and counter-extension were made by ingenious apparatus; the most exact coaptation of fractured bones was insisted on, as it was considered disgraceful to allow the patient to be maimed with a crooked or a shortened limb. Splints, and even waxed bandages, giving as much fixity, support, and immobility to the parts as is now done by starch and plaster of Paris, were then in use. Hippocrates also gives directions for the suspension of fractured limbs in gutters and slings. The projecting ends of bones, in compound fractures, were carefully resected. The bones of the cranium were trepanned for fracture with depression of bone, or for the evacuation of accumulations of blood or pus. Abscesses of the liver, and even of the kidneys, were opened with boldness and freedom. The thoracic cavity was explored by rude percussion and auscultation for the detection of fluids, and when found, paracentesis was performed, as was also done in abdominal dropsies. The rectum was explored by an appropriate speculum; fistula in ano and hemorrhoids were operated upon; club-feet were adjusted by bandaging and the use of stiff leather and leaden shoes; the bladder was explored by sounds for the detection of calculi; lithotomy was performed by specialists; gangrenous and mangled limbs were amputated; the dead fœtus was extracted with instruments from the uterus; venesection, scarification, and cupping were also practised in the days of Hippocrates.

In reading his works, we are impressed with the candor and honesty, as well as with the caution and practical experience, of this grand old master. In speaking of injuries of the head, he cautions the surgeon against hazarding a hasty prognosis, even though the case may appear at first to be a very slight one. Everywhere he exhibits caution without timidity, and yet we have abundant evidence of his boldness in practice, and of the astonishing amplitude of his resources. In the fourth section of "The Law," he declares that "inexperience is a bad treasure, and a bad fund to those who possess it, whether in opinion or reality, being devoid of self-reliance and contentedness, and the nurse both of timidity and audacity. For timidity betrays a want of powers, and audacity a want of skill."

As the writings of Hippocrates afford us the earliest information concerning ancient surgery, it is desirable to make a somewhat extended analysis of the principles and practice of the art as contained in these precious memorials, in order that the reader may be the better prepared to understand and appreciate what additions and improvements each subsequent age has contributed towards the advancement of surgical knowledge and the evolution of our present system of surgical science. In the examination of the monumental works of successive surgical authors, we will be thus enabled to observe to what extent they have adhered to the teachings of the Hippocratic school, and how far they have adopted newer methods, and developed improved principles, in the treatment of surgical cases. It will be the most interesting and instructive plan to make brief extracts from the works of Hippocrates, which will at the same time illustrate the style of this ancient author, and furnish examples of his careful modes of observation.

His treatise on the articulations commences with an elaborate account of dislocations of the shoulder-joint, and the several modes of reducing the same. He says:—

> I am acquainted with one form in which the shoulder-joint is dislocated, namely, that into the armpit; I have never seen it take place upwards nor outwards; and yet I do not positively affirm whether it might be dislocated in these directions or not; although I have something which I might say on this subject. But neither have I ever seen what I considered to be a dislocation forwards. Physicians, indeed, fancy that the dislocation is very apt to occur forwards, and they are more particularly deceived in those persons who have the fleshy parts about the joints and arm much emaciated; for in all such cases the head of the humerus appears to protrude forwards. And I, in one case of this kind, having said that there was no dislocation, exposed myself to censure from certain physicians and common people on that account, for they fancied that I alone was ignorant of what everybody else was acquainted with, and I could not convince them but with difficulty that the matter was so. But if one will strip the joint of the shoulder of the fleshy parts, and where the muscle (*deltoid?*) extends, and also lay bare the tendon that goes from the armpit and clavicle to the breast (*pectoral muscle?*), the head of the humerus will appear to protrude strongly forwards, although not dislocated, for the head of the humerus naturally inclines forwards, but the rest of the bone is turned outwards. The humerus is connected obliquely with the cavity of the scapula, when the arm is stretched along the sides; but when the whole arm is stretched forwards, then the head of the humerus is in a line with the cavity of the scapula, and no longer appears to protrude forwards.

After reading the above, one cannot but believe that Hippocrates had dissected the human body, and also made practical demonstrations on the cadaver. Continuing the subject, he speaks of the frequency of this dislocation, and remarks that many non-professional persons know how to reduce it. In those who are subject to frequent recurrence of this accident, he says, they can reduce it by putting the fist in the axilla, forcing the jóint upward, and then bringing the elbow to the chest. His next method is to bring the forearm to the spine, then to grasp the elbow, bend the arm upwards, and with the other hand support it behind the articulation. The third method, that by the heel in the axilla, has by some recent writers been erroneously credited to the inventive genius of our good master Ambroise Paré, in the sixteenth century. It is so well described in the third section of Hippocrates's Treatise on Articulations, that its transcription in this place may be interesting to the reader as a further illustration of the minute and careful style of this primitive writer on surgery:—

> Those who attempt to perform reduction with the heel, operate in a manner which is an approach to the natural. The patient must lie on the ground upon his back, while the person who is to effect the reduction is seated on the ground upon the side of the dislocation; then the operator, seizing with his hand the affected arm, is to pull it, while with his heel in the armpit he pushes in the contrary direction, the right heel being placed in the right armpit, and the left heel in the left armpit. But a round ball of a suitable size must be placed in the hollow of the armpit; the most convenient are very small and hard balls, formed from several pieces of leather sewed together. For without something of the kind the heel cannot reach to the head of the humerus, since, when the arm is stretched, the armpit becomes hollow, the tendons on both sides of the armpit making counter-contraction so as to oppose the reduction. But another person should be seated on the other side of the patient to hold the sound shoulder, so that the body may not be dragged along when the arm of the affected side is pulled; and then, when the ball is placed in the armpit, a supple piece of thong sufficiently broad is to be placed around it, and some person taking hold of its two ends is to seat himself above the patient's head to make counter-extension, while at the same time he pushes with his foot against the bone at the top of the shoulder. The ball should be placed as much on the inside as possible, upon the ribs, and not upon the head of the humerus.

Several other methods are described: over the shoulder of another person; over a pestle or pole; over a chair, a double door, or a ladder; with a special instrument called the *ambe*, which is a cushioned lever supported by a standard, with which apparatus Hippocrates reduced not only recent but also old dislocations.

All the dislocations which occur in the human body are described with care and wonderful accuracy, as are also various methods of reduction for each. Indeed, if we were obliged to rely solely upon what Hippocrates wrote upon the subject of dislocations, it would not be so serious a retrocession and misfortune to mankind as most persons would suppose; for in his treatise on articulations will be found minute and accurate descriptions of all the luxations of the joints, and methods of reduction, which, in ingenuity and practical utility, if not equal to those contained in modern treatises, are certainly not far short of them. His description of the four dislocations of the hip-joint reads like that of a modern book. In section 71 of this treatise he clearly describes the method of reduction by manipulation, saying: "In some the thigh is reduced with no preparation, with slight extension, directed by the hands, and with slight movement; and *in some the reduction is effected by bending the limb at the joint, and making rotation.*" Space will not admit of extensive quotation from this treatise. Every student will be amply repaid who will read the works of Hippocrates with care; the knowledge he will thus gain will keep him from falling into the common conceit that all that is ingenious and useful in surgery belongs to the present age.

In speaking of one of the modes of reduction of luxation of the hip-joint, Hippocrates exhibits his simplicity and freedom from any disposition to make a parade of surgical operations, a virtue which is not unfrequently wanting at the present day. "Section 70. Dislocation inwards at the hip-joint is to be reduced in the following manner (it is a good, proper, and natural mode of reduction, and has something of display in it, if any one takes delight in such ostentatious modes of procedure)."

It would be interesting to go into particulars and notice the main points of what he has written concerning dislocations and fractures of all the bones, and very curious to examine the mechanism of the various forms of engines and apparatus, simple and complicated, which were used in the treatment of these injuries at the time when he flourished.

Section 62 of "Articulations" is taken up with the treatment of congenital displacements of the ankle-joint and bones of the feet. He declares that club-foot is curable in most cases. The treatment should begin at as early a period as possible. He describes the modes of straightening, and tells how the foot is to be kept in position by soft compresses and bandages, "with cerate containing a full proportion of resin," cautioning at the same time against making the applications too tight. In addition to the above, he directs that a sole of leather, or of lead, shall be bound on beneath the other bandages. He sums up the treatment in the following manner:—

> In a word, as if moulding a wax model, you must bring to their natural position the parts which were abnormally displaced and contracted together, so rectifying them with your hands, and with the bandaging in like manner, as to bring them into their position, not by force, but gently; and the bandages are to be stitched so as to suit the position in which the limb is to be placed, for different modes of the deformity require different positions. And a small shoe made of lead is to be bound on externally to the bandaging, having the same shape as the Chian slippers had. [A sort of stout boot.] But there is no necessity for it if the parts be properly adjusted with the hands, properly secured with the bandages, and properly disposed of afterwards. This, then, is the mode of cure, and it neither requires cutting, burning, or any other complex means, for such cases yield sooner to treatment than one would believe. However, they are to be fairly mastered only by time, and not until the body has grown up in the natural shape; when recourse is had to a shoe, the most suitable are the buskins, which derive their name from being used in travelling through mud; for this sort of shoe does not yield to the foot, but the foot yields to it. A shoe like the cretan is also suitable.

Hippocrates discourses at some length on the difficulties and dangers attending the reduction of compound dislocations and compound fractures. He advises resection in certain cases where they cannot be reduced, saying, "Complete resections of bones at the joints, whether the foot, the hand, the leg, the ankle, the forearm, the wrist, for the most part are not attended with danger, unless one be cut off at once by *deliquium animi*, or if continual fever supervene on the fourth day."

It is alike unworthy of a writer, and false to the requirements of historical accuracy, to allow the judgment to be so far warped by undue admiration of a hero, as to paint his virtues in vivid colors and intentionally suppress his faults, or obscure them in intense shade. It would be very misleading to cite only those instances in which Hippocrates, and his immediate followers, pursued a course which at this period of time we most heartily commend; and to pass in silence those rude and barbarous practices which were then in vogue. The fear which Hippocrates entertained of the supervention of tetanus, in cases of compound dislocation of the larger joints, particularly if efforts at reduction were made, led him to advise that such dislocations should not be reduced, but be left to the slow process of healing, after long and profuse suppuration, leaving "thin and feeble cicatrices." He says, "It ought also to be well understood, that the patient must necessarily be much maimed and deformed." . . . "And yet in the case we are treating of (*ankle-joint*) those who are thus treated are saved; whereas, when the parts are reduced and allowed to remain in place, the patients die."

He says that the same rule applies to the wrist, the shoulder, the elbow-joint, and the knee. In regard to the latter he uses the following language: "When the os tibiæ, having made a wound at the knee, has protruded through the skin, whether the dislocation be outwards or inwards, in such a case, if the bone be reduced, death will be even more speedy than in the other cases, although speedy also in them. But the only hope of recovery is if you treat them without reduction." Compound dislocation of the lower end of the femur he regarded as far the most dangerous of all. The cause of death in all of the above cases is "convulsions;" by which he evidently means tetanus. "The patient will not survive more than a few days, for few of them pass the seventh day, being cut off by convulsions, and sometimes the leg and foot are seized with gangrene."

It would appear that the operation of amputation of the extremities was rarely resorted to in the age of which we are speaking. Hippocrates says that in sphacelus of fleshy parts, occasioned by wounds where the large bloodvessels have been too strongly compressed, or in fractures of the bones which have been too tightly bandaged, the parts drop off and most of such patients recover.

> In cases, then, of fracture of the bones, when strangulation and blackening of the parts take place at first, the separation of the dead and living parts quickly occurs, and the parts speedily drop off, as the bones have already given way; but when the blackening (*mortification*) takes place while the bones are entire, the fleshy parts, in this, also quickly die; but the bones are slow in separating at the boundary of the blackening, and where the bones are laid bare. Those parts of the body which are below the boundaries of the blackening are to be removed at the joint, as soon as they are fairly dead and have lost their sensibility; care being taken not to wound any living part; for if the part which is cut off give pain, and if it should prove not to be quite dead, there is great danger lest the patient may swoon away from the pain, and such swoonings often are immediately fatal. I have known the thigh-bones when denuded in this manner, drop off on the eightieth day; but in the case of this patient, the parts below were separated at the knee on the twentieth day, and, as I thought, too early, for it appeared to me that this should be done more guardedly. In a case which I had of such blackening in the leg, the bones of the leg, as far as they were denuded, separated at the middle on the sixtieth day.

In section fourth of his treatise on "Ulcers," we find minute directions for preparing cataplasms. Among the ingredients employed for different poultices, were linseed, mullein leaves, sedum or "live-for-ever" mallow leaves, wine and oil, and other simples of an emollient nature. For astringent poultices he employed alum, oak, vinegar, the juice of the unripe grape, galls, and many other articles.

In the treatment of ulcers Hippocrates also used a variety of mineral substances; such as the sulphate of copper, the sulphate of zinc, verdigris, lead, sulphur, arsenic, alum, natron, etc. He made use of "raw tar-water," which is believed to have been the liquid pitch described many ages after by Dioscorides. The application of this substance was a very near approach to the use of carbolic acid. Venesection and cupping were both practised by

Hippocrates; in connection with the latter he speaks of "*the cupping instrument.*"

It is interesting to read the directions of Hippocrates for the cure of fistula in ano. He gives several methods, and minute details for the after-treatment. The following is from the fourth section of his treatise on "Fistulæ:"—

> Another method of cure: taking a very slender thread of raw lint and uniting it into five folds of the length of a span; and wrapping them around with a horse-hair; then having made a director (specillum) of tin, with an eye at its extremity, and having passed through it the end of raw lint, wrapped around as above described, introduce the director into the fistula, and, at the same time, introduce the index finger of the left hand *per anum;* and when the director touches the finger, bring it out with the finger, bending the extremity of the director and the end of the threads in it, and the director is to be withdrawn, but the ends of the threads are to be knotted twice or thrice, and the rest of the raw threads are to be twisted around and fastened into a knot. Then the patient is to be told that he may go and attend to his matters.

Then follow directions for tightening the ligature every day until it cuts through, and other after-treatment.

Hippocrates devotes an entire treatise to the subject of *hemorrhoids.* After describing the disease, and mentioning its causes, he proceeds to enumerate the several modes of treatment, remarking that "cutting, excising, sewing, binding, applying putrefacient means to the anus, all these appear to be very formidable things, and yet, after all, they are not attended with mischief." He approved of the actual cautery used in the most decided manner. "Make the irons red-hot, and burn the pile until it be dried up, and so as that no part may be left behind. And burn so as to leave none of the hemorrhoids unburnt, for you should burn them all up." In that day no ethereal or letheial vapor or draught was given to the suffering patient; we are told: "when the cautery is applied, the patient's head and hands should be held so that he may not stir, but he himself should cry out, for this will make the rectum project the more." The expansible *speculum ani* was in use in the fifth century before the Christian era. Hippocrates, when treating of internal condylomata, in the fifth section of the book under consideration, says, "if the condyloma be higher up, you must examine it with the speculum, and you should take care not to be deceived by the speculum; for when expanded it renders the condyloma level with the surrounding parts, but when contracted, it shows the tumor right again." In the sixth section he advises a most ingenious method of using the actual cautery within the rectum, by introducing it through a canula. "An iron that exactly fits is to be adapted to it; then the tube being introduced into the anus, the iron, red hot, is to be passed down it, and frequently drawn out, so that the part may bear the more heat, and no sore may result from the heating, and the dried veins may heal up."

Suppositories were also employed by Hippocrates. "But if you wish to effect the cure by *suppositories*, take the shell of the cuttle-fish, a third part of plumbago, bitumen, alum, a little of the flos æris, galls, a little verdigris; having poured a small quantity of boiled honey on these, and formed an oblong suppository, apply until you remove them."

In the treatment of *injuries of the head*, the trepan was used with more freedom than at the present time, though not without a considerable amount of caution. The instrument, so called, is believed to have been the same as that described by Celsus, in the first century, under the name of the *modiolus*, a tubular saw, not unlike our modern trephine. Hippocrates refers to the differences between the bones of children and those of adults. In section 18 of his treatises on "Injuries of the Head," he says:—

> If the bone is laid bare of flesh, one must attend and try to find out, what even is not obvious to the sight, and discover whether the bone be broken and contused, or only contused; and if, when there is an indentation in the bone, whether contusion, or fracture, or both be joined to it; and if the bone has sustained any of these injuries, we must give issue to the blood by perforating the bone with a small trepan, observing the greatest precautions, for the bone of young persons is thinner and more superficial than that of elder persons.

In section 21 he gives directions how to perform this operation:—

> And in trepanning you must frequently remove the trepan, on account of the heat in the bone, and plunge it in cold water. For the trepan being heated by running around, and heating and drying the bone, burns it and makes a larger piece of bone around the sawing to drop off, than would otherwise do so. And if you wish to saw at once down to the membrane, and then remove the bone, you must also, in like manner, frequently take out the trepan and dip it in cold water. But if you have not charge of the treatment from the first, but undertake it from another after a time, you must saw the bone at once down to the meninx with a serrated trepan, and in doing so must frequently take out the trepan and examine with a sound (*specillum*), and otherwise along the track of the instrument. For the bone is much sooner sawn through, provided there be matter below it and in it, and it often happens that the bone is more superficial, especially if the wound is situated in that part of the head where the bone is rather thinner than in other parts. But you must take care where you apply the trepan, and see that you do so only where it appears to be particularly thick, and having fixed the instrument there, that you frequently make examinations and endeavor by moving the bone to bring it up.

He also cautions against placing the trepan over sutures.

Space will not admit of any further examination of the inestimable writings of Hippocrates. Enough has been quoted to show that surgery had reached an important degree of development in his day, and that he was a man of marked ability, and worthy of the admiration of his own and succeeding ages. The inhabitants of Argos voted him a statue of gold; he was more than once crowned by the Athenians, and, though a stranger, was initiated into the most sacred mysteries of their religion, the highest distinction which they could confer. After his death, universal and almost divine honors were paid to his memory, temples were erected to him, and altars were covered with incense and grateful offerings. He was probably the first public teacher of the healing art, the first to disclose its secrets and strip it of its mystic veil, for we are told that he gave oral discourses on anatomy and other branches of medicine.

There is an enormous mass of ancient writings on medical and surgical subjects, which is still extant, over which critical scholars have for centuries past puzzled their brains to determine whether they were written by Hippocrates himself or by some of his disciples in a subsequent age. The "genuine" treatises of Hippocrates have been cut down more and more, so that at present they are embraced within the compass of seven or eight hundred octavo pages; the apochryphal works are mostly attributed to his followers, for the teachings of this great physician and surgeon formed the foundation of what was long after known as the Hippocratic school.

We now pass on by a long stride from the fifth to the third century before the Christian era, finding nothing to record in the way of improvement in the science or art of surgery. Praxagoras of Cos was the last of the Asclepiadæ whose name has survived. He is said to have been a bold surgeon, to have incised the fauces freely, and to have excised portions of the soft palate in bad cases of cynanche; and even to have made incisions into the abdomen and bowels to remove obstructions, when milder methods failed.

About the beginning of the third century B. C., the famous school of

Alexandria was established, with Aristotle, the Master; Herophilus and Erasistratus, the great anatomists and physicians, enjoying the liberal advantages for the cultivation of science, and particularly for the dissection of the human body, which had been hitherto prohibited for perhaps all time. The knowledge of the structure of the human body which the dissection of its members and organs furnished to the surgeons of that period, must have resulted in great improvement in practical surgery. Very many of the anatomical names which are now in use, are said to be have been given to the parts by Herophilus. He described the structures of the eye with great accuracy, naming the several membranes of that organ—as the retina and others—which names are still in use. The extraction of the crystalline lens for the cure of cataract is said to have been first performed by him. Erasistratus is reputed to have been a bold and skilful surgeon. "In scirrhosities and tumors of the liver, he did not scruple to make an ample division of the integuments, and try applications to that viscus itself. He followed the same practice in diseases of the spleen, which he regarded as of little consequence in the animal economy." He invented a catheter for use in cases of retention of urine, which is the first one mentioned in ancient surgical writings, and which long bore the name of the catheter of Erasistratus.

It was about this period that the healing art was divided into three distinct professions, viz: dietetics, pharmacy, and surgery. Some branches of the latter, at least lithotomy, were practised exclusively by specialists. As an evidence of the depravity of these cutters-for-stone, we are told that Tryphon, the usurper, had the story set in circulation that the young prince Antiochus the Sixth, surnamed Theos, was affected with stone in the bladder, and that under pretext of ridding him of this debility, the lithotomists were employed to perform upon him, with the understanding that he should perish under the operation.

Xenophon of Cos, said to have been one of the followers of Erasistratus, has received the credit of having first resorted to firm ligation of a member for arresting hemorrhage. Mantius, a pupil of Herophilus, wrote a treatise on surgical dressings. Andreas of Carystus wrote on the union of fractured bones, and was the inventor of several powerful and clumsy machines for reducing dislocations of the hip-joint. After all, it does not appear that any great progress was made by the professors and followers of the Alexandrian school of science, anatomy, and medicine. It is possible, however, that much that was valuable in surgical literature, as in so many other departments of useful knowledge, may have perished in the conflagration of the famous national library at Alexandria, in the time of Julius Cæsar.

During the first six hundred years of the existence of Rome, that city was entirely without physicians and surgeons, trusting for cures to spells and incantations. Cato the censor gravely wrote down the mystic words of incantation for curing dislocations and fractures of the bones. Public edicts were issued, "discouraging all countenance to the professed exercise of physic, and recommending faith in traditionary prescriptions and religious rites." Archagathus, a Greek, from the Alexandrian school, practised surgery in Rome in the time of Lucius Æmilius and Marcus Livius. He was the first surgeon who practised in the eternal city of whom we have any knowledge. He acquired considerable fame, and was called "the healer of wounds," but using his knife and his burning-irons rather freely on the Roman rabble, he soon lost caste, and was banished from Rome with the ignominious title of "the executioner." About the year 96 B. C., a native of Bithynia, who assumed the name of Asclepiades, settled in Rome and acquired great celebrity as a physician and surgeon. Asclepiades of Bithynia must not be confounded with forty other ancient characters who bore this name. The writings of this physician, though no longer extant, are quoted by Celsus, Scribonius Largus, Cælius Aurelianus, Galen, Oribasius, Aëtius, Pliny, and twenty other classical authors, by whom many valuable fragments of his medical writings have been preserved to the present time. A beautiful antique bust of Asclepiades is to be seen in the Vatican at Rome. His practice was chiefly medical, though several surgical procedures are attributed to him. He advised that minute punctures should be made in the abdominal walls for the escape of the fluid in ascites. He employed free blood-letting, by the lancet and cupping, and also resorted to scarification of the fauces in acute diseases of the throat. It is said that he was the first surgeon who proposed laryngotomy. His influence was so great that his followers were regarded as a distinct sect; the Asclepiadic sect in Physic. It was probably owing to his example and skill that the ancient grudge against physicians and surgeons abated in Rome about this time. He was the contemporary of Cæsar, and the personal friend of Cicero, who entertained not only an exalted opinion of him, but also a high estimation of the art of healing. "Nothing," he says, "brings men nearer to the gods than the giving of health to their fellow-creatures." Cassius, a disciple of Asclepiades, wrote several anatomical and surgical works. In one of the latter he makes the statement that wounds of the head inflicted on one side, are followed by paralysis on the other, as a consequence of the decussation of the nerves; which explanation attests the accuracy of his knowledge of anatomy, and his carefulness in observation.

In the early years of the first century of Christian grace, there flourished at Rome the most distinguished and elegant writer on surgery that ancient literature can boast of. Aurelius Cornelius Celsus wrote eight books on medicine, which have, most fortunately, been preserved to the present time; they have always been admired by classical scholars for the purity and beauty of their latinity, and highly valued by our own profession as one of the most precious monuments of antique surgery now extant. Since the art of printing has been in operation, scores of editions, in Latin and in many other languages, have been required to satisfy the demands of medical readers. As it was with the treatises of Hippocrates, so is it necessary with the books of Celsus to furnish the reader with a brief but careful analysis of their contents, in order that he may appreciate the advancement made in surgery during the period of almost five centuries which had intervened between the advent of the former and the time in which the latter flourished. The question has been raised as to whether Celsus was himself a physician and surgeon, or a mere compiler; whether his work was the product of one who had studied and had practical knowledge of the various subjects embraced in it, or the compilation of a scholar who had pursued these investigations as a mere part of the culture required for a finished general education. To any person who will attentively read the work "De Medicina," it will I think furnish abundant proof that the author was not only an actual practitioner of ample experience, but also one of careful observation, and possessed of sound judgment; and though he may not have devoted his time exclusively to the cultivation and practice of the healing art, it is more than probable that his descriptions were drawn from actual observation, and that he recommended in the way of treatment what his own personal experience had confirmed as useful. The precise dates of his birth and death are not known. He flourished in the Augustan age; was the contemporary of Horace, Virgil, and Ovid; and lived in the reins of Tiberius, Caligula, Claudius, and Nero. The seventh and eighth books of Celsus are entirely devoted to surgery. They furnish ample evidence of great improvements in this science and art since the days of Hippocrates. Celsus furnishes us with a brief history of the origin, early development, and progress of our Art, and of the several sects in medicine which existed in his time. He speaks of many surgeons and their works, concerning whom we at present have no other knowledge, and compliments some of his immediate predecessors. He mentions the names of no less than ninety authors, some of whom he refers to many times; thus I find him quoting the opinions of Hippocrates in seventeen different places, those of Erasistratus in fourteen, and those of Asclepiades in twenty.

> But in that branch of medicine which treats of manual operations, it is evident that all the advantage (although assistance may be derived from other means) is to be effected by these. Now although this part is the most ancient, yet it was cultivated more by Hippocrates, the father of all medicine, than by his predecessors; afterwards, being separated from the other branches of the healing art, it commenced to have its own distinct professors, and received considerable improvements in Egypt, principally by the authority of Philoxenes, who had treated of surgery most carefully in several volumes. Gorgias also, and Sostratus, Heron, and the two Apollonii, Ammonius of Alexandria, and many other celebrated men, all contributed by their researches to surgery. At Rome, also, professors of no mean talent, and, particularly of late, Tryphon the elder, and Euelpistus, and Meges, the most learned of them all, as it would appear by his writings, he having changed several things for the better, also contributed considerably to the art.[1]

It is quite obvious that human dissection was practised in Celsus's day, though he condemns both human and animal vivisection, saying: "To dissect the bodies of living animals is both cruel and superfluous; but the examination of dead subjects is imperatively necessary for students, for they ought to know the position and order of the parts, which are demonstrated with greater facility in dead bodies." His osteology is particularly accurate, and many of his descriptions of the different organs, though quite brief, are fairly good. He employed the Greek names for parts, which are the same as those still in use. Among them may be mentioned, diaphragm, peritoneum, omentum, jejunum, pylorus, ureter, zygoma, vertebra, femur, and cartilage. Before proceeding to analyze his surgical writings, it will be well for the reader to know what Celsus regarded as the necessary qualifications of a surgeon:—[2]

> A surgeon ought to be young, or at least not far advanced in years; to have a firm, steady hand, and never liable to tremble; to be no less dexterous with the left than with the right; to have an accurate and penetrating sight; an intrepidity of mind sufficient to bear up against the shrieks of his patient, yet compassionate to him whom he has undertaken to cure; he should neither hasten more than the case requires, nor cut less than is necessary; but effect his purpose in every case, as if he were immovable by the importunities of his patient.

He gives minute directions for the removal of arrows and other weapons which have been driven deeply into the soft parts of the body, and also into the bones and joints. He advises the greatest caution in enlarging the wounds, or in making counter-incisions, with a scalpel, to observe the position of the nerves, veins, and arteries; but "when any of these is exposed, it must be seized by a blunt hook, and held aside from the knife." He speaks of using forceps, "as in drawing a tooth." If the arrow or other missile is driven into the bone, and is so firmly impacted that it cannot be extracted, he remarks, "The last resource, when we have failed to remove it, is to perforate the bone near the part with a trephine, and from that opening to excise the bone in the form of the letter V, so that the lines may converge towards the point of the weapon; this being done, it must necessarily give way, and be easily extracted."

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[1] Medicin. lib. vii. Præfatio.

[2] Ibid.

In the treatment of indolent ulcers and chronic fistulæ, Celsus recommends the excision of the indurated borders of the former, and the laying open of the latter, by the guidance of a probe, the free excision of the callous portions along their track, and treating both with wine and other applications which were believed to promote the growth of new and healthy granulations. What more sensible course could be pursued at the present time? In the treatment of fistula in ano, he resorted to the knife in some cases, as well as in others to the ligature, which latter, as we have already seen, was used by Hippocrates.

Chapter VII. of Book VII. is entirely devoted to "diseases of the eyes, and those which are cured by manual operations." It concludes a wide range of subjects, tumors of the lids, pterygium, adhesion of lids, inversion of eyelashes, bagging of eyelids, staphyloma, cataract, etc.

As Celsus is the most ancient writer who has described the operation for cataract, I will transcribe his account of it:—

> Previous to the operation, the patient ought to be put on a spare diet, to drink nothing but water for three days, and the day previous to abstain from everything. After these preparations, he is to be seated in a light place, with his face towards the light in such a manner that the physician may sit opposite to him, a little more elevated; but an assistant should stand behind the patient that he may hold his head immovable, for by a slight motion the sight may be lost forever. Besides, the eye to be operated on must be held more steady by applying wool on the other eye, and binding it on. Now, the left eye must be operated on by the right hand, and the right eye with the left hand. Then a sharp-pointed needle, perhaps not too slender, is to be directed straight through the two external tunics, at the intermediate between the pupil and the temporal canthus of the eye, opposite the centre of the cataract, care being taken to wound no vein. It should not be introduced with timidity, because it enters a void space; for a person of very moderate skill cannot but know when he has touched it, as there is no longer any resistance to the instrument. When it has reached the part, the needle is to be inclined towards the cataract itself, and gently moved up and down there (*or rotated*), and the operator ought to depress gradually below the region of the pupil; when it has passed the pupil it should be pressed a little more forcibly, that it may sink to the inferior part. If it remain there, the operation is completed; if it rises again it must be more cut with the same needle, and divided into several pieces, which being in separate portions are not only more easily concealed, but obstruct vision less. After this the operator must withdraw his needle in a straight direction, and the white of eggs, spread upon wool, is laid on [the eye], and over that something to restrain inflammation, and so bound up.

Then follow explicit directions for the after-treatment. This is certainly a very remarkable and an extremely delicate surgical operation to have been performed in so remote a period of antiquity. The instructions for the performance of the operation as given by Celsus are a model of conciseness, accuracy, and simplicity. It is impossible to contemplate the skill of the Roman surgeon of the first century of our era without emotions of astonishment and admiration.

In following the regular order of his surgical writings we next come to Chapter IX. of Book VII., which is taken up with "the mode of repairing defects in the ears, lips, and nose." This includes the operation for harelip: the edges having been pared, the margins are to be brought gently together, but, in cases where they cannot be coaptated, semilunar incisions are to be made beyond the parts to be joined in order to aid their approach to each other. Stitches, and not pins, were used in such plastic operations.

The tenth chapter directs the treatment of nasal polypi by incision with a sharp knife, and plugging the nostrils with compresses of lint wet with a styptic liquid to arrest the hemorrhage. Chapter XII. relates to oral surgery.

First of all, the mode of extracting teeth. He would have the gum separated from the tooth, which is to be extracted with the forceps, care being taken, if the tooth is firmly fixed, not to dislocate the jaw.[1] Celsus gives the following directions, which strike me as very ingenious and practicable. "But if the tooth be carious, the cavity must be filled up, either with lint or lead well adapted to it, lest it break under the forceps." He also admonishes the operator not to seize the alveolar process with the forceps, in fear of extensive fractures of this part. Next follows the mode of fastening teeth which have been loosened by blows and falls. This is to be done by fastening the loose teeth to the firm ones by means of gold. He does not state whether a wire or a plate of gold. He tells us to extract the fangs of teeth with a special forceps, made for the purpose. (*Rizagra*, a root extractor.) The tonsils are to be raised with a hook and cut off with a scalpel; and the uvula to be truncated, when elongated, after seizing it with a small volsella. In cutting the frænum linguæ, he cautions against wounding the sublingual vessels.

Chapter XIII. deals with the operation for the extirpation of bronchocele, as, he says, the Greeks term this tumor. The differential diagnosis of umbilical tumors, and of omental and intestinal hernia, is given in Chapter XIV., and also the treatment by clamps and by the actual cautery. The next chapter treats of paracentesis abdominis. He speaks of the different points at which a puncture can be made, and directs that a canula of lead, or of brass, be inserted into the puncture, that "the major part" of the fluid be discharged, and that the canula be then plugged and re-opened each day until no fluid remains. Chapter XVI. is on "wounds of the intestines and their treatment." Celsus tells us that wounds of the small intestines are fatal, but that "the larger intestine may be sewed; not with certain confidence of a cure, but because a doubtful hope is preferable to certain despair, for sometimes reunion is effected." In the next chapters he treats of hernia, hydrocele, and varicocele. He used bandages with pads for hernia, and cut down upon and enlarged the opening in case of strangulation. In hydrocele he laid open the scrotum freely with the scalpel. In varicocele he opened the sheath of the cord, brought out the varicose vessels and applied clamps to obliterate them. If "the testicle hangs down in a dangling unseemly manner withal," he says the only remedy is to remove it. "The groin must be incised, and the middle coat drawn out and cut away; the same must be done with the lowest tunic, and the nerve (*cord*) by which the testicle depends cut off; after this the veins and arteries must be secured by a ligature at the groin, and then be cut off below it."[2] In Chapter XXV. he gives directions for making a prepuce, "for persons who are desirous, for the sake of appearance, to have it (*the glans*) covered," both in cases of congenital absence of the prepuce and after circumcision. In the former he brings and fastens the integument in front of the glans, and then makes an incision around the penis near the pubis, "so that a denuded circle appears near the pubis; over this lint must be applied, that the flesh may grow and fill it up." This is an æsthetical refinement which was, perhaps, peculiar to the Augustan age; it has not, as yet, been revived in the present day. Phimosis was treated by removing a V-shaped piece of the prepuce at its under side.

We now come to one of the most interesting chapters in all the works of Celsus.[3] It contains the earliest account which we possess of the mode of operating for stone in the bladder. It begins with a brief account of catheterization saying:—

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[1] This accident I have known to occur, in the hands of a professional dentist.

[2] Medicin. lib. vii. cap. xxii.

[3] Ibid., lib. vii. cap. xxvi.

> For this purpose, then, brazen catheters are made; and that they may serve in all cases, both large and small, the surgeon should keep by him three for males and two for females. The largest male catheter should be fifteen fingers' breadth in length, the next twelve, and the smallest nine; the largest female catheter should be nine fingers' breadth in length, and the smallest six. Now these ought to be slightly curved, but the male catheters more particularly so, and very smooth, and neither too stout nor too slender.

The directions which Celsus gives for the introduction of the catheter are admirable. When a stone becomes impacted in the urethra and cannot be extracted "with an ear-probe, or with the instrument with which they extract the stone in lithotomy," he directs that the prepuce shall be drawn forward and ligated, and an incision be made on a line with the urethra over the calculus, on the removal of which, the integument being permitted to retract, the opening is closed and the urine follows the natural channel, and thus a fistula is avoided. Is not this a beautiful example of ingenuity and practical skill?

The "Celsian method" of cutting for stone in the bladder, which is also called "cutting on the gripe," is the most ancient and the most famous of all the modes of performing lithotomy recorded in the annals of surgery. The operation is, however, referred to, but forbidden to be done by surgeons, in the oath of Hippocrates. This was probably in consequence of the low repute into which the specialists in lithotomy had brought the operation by their boastful pretensions and their ill success. The Celsian method was followed exclusively for sixteen hundred years, when other and improved modes were introduced, as we shall see hereafter. The description which Celsus gives us of this operation, is too lengthy to be transcribed in this short history. In brief, it consists in introducing the fingers of the left hand into the rectum, by which means the calculus is brought down to the neck of the bladder; "a lunated incision must be made through the integuments immediately over and extending to the neck of the bladder, near the anus, with the horns a little inclined towards the ischia; then a second incision is to be made in a transverse form in the convex part of the wound, so as to open the neck of the bladder freely, that the urethra may be laid open, and the wound should be a little larger than the calculus." He then speaks of a crotchet, a sort of spoon, smooth outside and rough on the concave side, by which the stone is to be removed. He speaks also of an improved instrument, for cutting, invented by Meges, being "a straight instrument with a broad back (*rounded*) at its upper part, and semicircular and sharp at its lower extremity," which was to be used in place of the ordinary knife. He gives many precautionary instructions concerning every step of the operation. In regard to very large calculi, he says:—

> But if at any time the stone is so large that it cannot be extracted, without lacerating the neck of the bladder, it must be split. The author of this invention was Ammonius, who on that account obtained the cognomen of Lithotomus, *the stone-cutter*. It is done in this manner: A crotchet is introduced to the calculus, so as to hold it fast while being struck, lest it should recoil backwards; then an iron instrument, of moderate thickness, with a thin edge, but not sharp, is to be employed, and being applied to the stone, and struck at the other extremity, splits it, great care being taken that neither the instrument itself nor any fragment of stone shall injure any part.

Then follow directions for washing out the bladder with warm water, by means of a syringe, and an entire chapter is devoted to after-treatment, and to "gangrene after lithotomy." Celsus regarded the operation of lithotomy as a very dangerous one, only to be done with many restrictions, and as a last resort. It was to be only performed in the spring; young persons and women should be the only subjects.

He gives the mode of performing an operation for imperforate vagina, both congenital and traumatic, the parts to be kept from closure by "a leaden pipe."[1] In the next chapter he treats of "the method of extracting a dead fœtus from the womb." He directs that "the utmost prudence and tenderness" shall be used in every step of the operation, as well as in the introduction of the hand into the uterus; that when the position of the fœtus has been ascertained, "the duty of the physician is to turn the child either upon its head or on its feet, if it be placed otherwise. And if there be no other impediment, he lays hold of the hand or foot, and places it in a straighter position." He advises the use of a polished crotchet, to be fixed either in the eye, ear, mouth, or forehead, by which careful extraction is to be made, only at the time of a uterine contraction. Directions are also given for the amputation of limbs, for evisceration, and for decapitation, in certain cases of difficult delivery. Thus it is seen that the surgery of obstetrics had reached no mean degree of practical utility in the first century of our era. Chapter XXX. of Book VII. relates to the treatment of diseases of the rectum. The indurated borders of fissures are to be excised; warty excrescences are to be "seized with a forceps, and cut off near their root." Piles are to be ligated, or to "be taken hold of by one or two small hooks, and incised a little above the base; neither must any part of the head be left, nor any part of the anus be taken away; which may be accomplished by not drawing the hooks either too much or too little. Where the incision has been made, a needle is to be passed through the orifice of the vein, and below this a ligature applied."

The next chapter is on the treatment of "troublesome" varicose veins. The searing-iron is used for the simpler forms, and excision resorted to in cases where the veins are "much convoluted, and disposed into circles as it were, with a number of them interlacing each other." The last chapter of the seventh book (Chap. XXXIII.) is on the surgical treatment of gangrene. In this little chapter we find all that Celsus has to say concerning amputation of the limbs. In this we note a very great advance and improvement on the mode described by Hippocrates, who, it will be remembered, forbade the surgeon to cut any but the dead tissues, and those only after a line of demarcation had been formed, and for the purpose of getting rid of the putrescent mass. Celsus directs, on the contrary, that it should rather include a portion of sound flesh, than leave any of the diseased. He avoided the joints, performing the circular operation, retracting the parts, using the saw, and preserving enough integument to cover the stump and bone in every direction. As the account is interesting and brief, I will transcribe it entire:—

> But even this is attended with very great danger; for patients frequently die during the operation itself, either from syncope or from hemorrhage. But in this as well as in some other cases, it is of very little importance whether the remedy be safe—it is our only one. Therefore the incision is to be made with a scalpel through the flesh as far as the bone, between the healthy and diseased portion; but not over a joint, and it should rather comprehend a portion of the sound limb than leave any part of it diseased. When we come to the bone, the sound flesh must be retracted from it, and the section continued around it, so as to lay that part of the bone bare; then that is to be cut off with a small saw, as near as possible to the sound adherent flesh: and the asperities of the bone produced by the saw being smoothed, the skin is to be brought over it; which in an operation of this kind ought to be very free, in order to cover the bone in every direction as much as possible. The part which has not been sufficiently covered with skin must be dressed with lint, and a sponge moistened with vinegar bound over it.

There is nothing said in this place as to the mode of arresting hemorrhage, which has led some persons who have merely read this chapter to conclude that the ligation of arteries in amputations was not practised in the days of Celsus. This I believe to be an error. This author had already discoursed extensively on the means of arresting hemorrhage, in the twenty-sixth chapter of his fifth book, and incidentally elsewhere in his works. In his chapter on wounds, after speaking of various styptics and of pressure, he adds: "But if these remedies are also ineffectual in restraining the hemorrhage, the bleeding vessels are to be taken up, and two ligatures to be applied, one on each side of the wound, and then to be divided between the ligatures, that they may both unite together by anastomosing branches, and effect an obliteration of their orifices." That the ligature was preferred to the searing-iron, may be plainly seen by the sentence which follows immediately after the above quotation: "When the case does not admit of this last remedy, we may employ the actual cautery."

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[1] Ibid., lib. vii. cap. xxviii.

The first chapter of the eighth book of Celsus is an excellent epitome of osteology as studied in his age. It is followed by a discourse on diseases of the bones, the removal of dead bone by rasping, scraping, and the use of the trephine. Hippocrates mentions, but does not describe, the trephine. Celsus describes it as follows: "The modiolus is a hollow, cylindrical instrument, the lower edge serrated, through the middle of which a centre-pin is introduced, which is also surrounded by an inner circle." He mentions two kinds of perforator: "one is similar to that which is used by carpenters; the other with a larger head, etc."[1] He says that the trephine is revolved by a strap, like a perforator, as we see nowadays with old-fashioned drills. He instructs as to pressure, speed, time to remove the centre-pin, etc. When large pieces of diseased bone are to be removed, perforations are to be made at short intervals around the borders. The dust must be inspected to determine the sound or diseased condition of the bone. The chisel and mallet were also used. Celsus's directions for trephining the skull are more precise, and indicate a better knowledge of anatomy, than those of Hippocrates. The two tables of the skull are here mentioned. In speaking of the diagnosis of fracture of the skull, and the liability of mistaking a suture for this injury, he takes occasion to commend the ingenuousness of "the Father of all Medicine."

> Hippocrates has recorded that he was himself deceived by the sutures; this candid acknowledgment of error is truly noble in the characters of great men, who have a just estimate of their own superior ability; for little minds never abstract anything from themselves, because they have nothing to spare; while the ingenuous admission of an error is congenial to a great mind, which will still have enough for us to admire, especially in the discharge of a duty which is handed down to posterity for its benefit, that it may not be deceived in the same way that another was deceived before it. Nothing but the merits of this eminent professor could have led us into such a digression.[2]

The remainder of the work is taken up with an account of fractures and dislocations of nearly all of the bones of the body. There is no considerable improvement in the treatment given by Celsus on that practised in the days of Hippocrates. In fact, he often quotes from, or refers to, the opinions of the old Masters. He entertained the same fears as to the danger attending reduction of compound dislocations that Hippocrates did. I will close my review of the surgery of Celsus by a quotation from chapter tenth, of book eighth, where he treats of ununited and badly united fractures.

> But if at any time the bones have not united, in consequence of the dressings being frequently removed and the parts disturbed, the treatment to be adopted is obvious;

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[1] Ibid., lib. viii. cap. iii.

[2] Ibid., lib. viii. cap. iv.

for union may yet take place. If the fracture be of long standing, the limb is to be extended, in order to produce a fresh injury; the bones must be separated from each other by the hand, that their broken surfaces may be rendered uneven by the grating against each other; and if there be any fat substance, it may be abraded, and the whole reduced to a recent accident; yet great care must be employed, lest the ligaments or muscles be injured.

Sometimes, however, the bones are accustomed to unite in an oblique direction; and by this the limb becomes both shorter and deformed, and if the ends be very much pointed, continual prickings will be felt. For this reason, the bones ought to be fractured again, and again set. It is effected in this manner.

Then follow minute directions for refracturing bones, and for the subsequent treatment, all of which are very good. And here endeth our brief summary of the surgery of the first century of our era, as furnished to us in the admirable treatises of Aurelius Celsus.

Soranus, surnamed the younger, a native of Ephesus, was a student of the Alexandrian school, and a distinguished disciple of the methodic sect of Themison; he located himself at Rome, and practised with high reputation under the reigns of Trajan and Hadrian (98–138 A. D.). The writings of Soranus have perished, with the exception of certain fragments, unless it be true, as has often been alleged, that the work of Cælius Aurelianus, the Numidian, is nothing more or less than a Latin version of Soranus. In his treatise "*De utero et pudendo muliebri*," Soranus assures us that he had dissected the human cadaver and not merely monkeys, and speaks of the use of the vaginal speculum and of the uterine sound. He gives a lucid account of the differential diagnosis of pregnancy from ascites and solid tumors, by means of percussion, palpation, and succussion. His works give evidence of improvements in obstetrics and gynæcology. He also wrote a treatise on fractures, a portion of which is still extant. This work, "*De signis fracturarum*," was printed in Greek and in Latin at Florence, in folio, in 1754, with notes by Antonio Cocchi.

Antyllus was a distinguished and skilful Italian surgeon, who flourished in the latter part of the first or in the early part of the second century. His works have also perished, but from the fragments which are preserved by the quotations of subsequent writers, we are enabled to learn that he made important additions and improvements in surgery. He was the first, of whom we have any knowledge, to recommend bronchotomy in cases of cynanche, or other inflammations attended with tumefaction, which threatened suffocation. He advised arteriotomy in preference to venesection, where free blood-letting was indicated. He speaks of the operation for cataract by extraction of the lens, but advises it to be done when the cataract is small, from an apprehension that, if large, it could not be extracted without the escape of all the humors of the eye. He operated for the radical cure of hydrocele by free incision of the parts.

The intimate relations of surgery to anatomy render any improvement of the latter an important means of advancing the former. This leads me to make a brief allusion to the distinguished anatomist and surgeon, Rufus of Ephesus, who unquestionably flourished under the reign of Tiberius, about the years 96–117 A. D. His little treatise, still extant, "*De appellationibus partium corporis humani*," is the earliest example of lexicography relating to our profession which we possess. The purpose of Rufus was to furnish a correct general idea of anatomy, and to end the perplexities which the student of that day encountered in reading ancient medical authors, from the many appellations which had been given to the same parts. Rufus mentioned the recurrent nerve, which had then been newly discovered, and declared that it was not pressure on the carotid arteries, as had been previously believed, but pressure on this nerve that took away the voice.

Galen, whose writings were regarded as the highest authority on all medical subjects for not less than thirteen hundred years, was born at Pergamus, in Asia Minor, about the year 130 of our era. Many of his works are extinct, and yet, what remain extant, are five and one-half times more voluminous than the combined scriptures of the Old and New Testament. They are largely an extended commentary on the works of Hippocrates, with notes from various medical and surgical authors who had written during the time which intervened from the fifth century before Christ to the middle of the second century after His advent. Galen cannot be said to have made many important improvements in anything which related to surgery. In four cases he detected dislocation of the head of the femur backwards, a variety of luxation not mentioned by Hippocrates; and he records two cases of spontaneous dislocation of the same bone. He is the first to speak of the use of the trepan for the perforation of the sternum in case of empyema, or of mediastinal abscess. Galen advises the ligation of arteries in cases where a profuse hemorrhage cannot be arrested by astringents, cold, or other means. He gives also a good description of the aneurismal tumor. He was skilled in the art of bandaging, and continued to employ the cumbrous and complicated machinery of a former age, in the treatment of fractures and dislocations of the bones. The reader must not infer any want of respect for Galen, from the above remarks; he is here only spoken of in reference to surgery. His fidelity in the description of maladies was equal to that of Hippocrates, and the exquisite discrimination of his judgment of diseases was not excelled by that of any medical writer of antiquity.

The next medical author of any importance after Galen, was Oribasius, also a native of Pergamus, a pupil of Zeno, who flourished about the middle of the fourth century. He was a man of sterling qualities and a skilful practitioner. He was a careful compiler, a judicious editor, and a sensible commentator. He was the physician and friend of Julian, surnamed the Apostate, and followed him into Gaul; and when Julian became emperor, he appointed Oribasius quæstor at Constantinople.[1] It was at the request of Julian that he wrote his great "*Collectorum medicinalium libri*," consisting of seventy books, of which only seventeen have survived the ravages of time. He says in his preface, "I have finished long since, divine Cæsar, the abridgment of the books of Galen, which you charged me to make, during our residence in nearer Gaul. You deigned to express your satisfaction on the subject, and you enjoined upon me, at the same time, another work—that of reducing to a single volume all that the most illustrious physicians have taught, of utility, on the healing art. I have, therefore, resolved to gratify you according to my abilities. I shall be careful to omit nothing of what Galen had said, because he is, of all those who have written on these matters, the one who has treated his subject with most clearness, reason, and method. He shows himself, besides, the faithful interpreter of the principles and sentiments of Hippocrates."

The abridgment which Oribasius subsequently prepared of his great work, for the benefit of his son, has reached us complete. It is in nineteen books. In the ninth book of the synopsis, published by Stephens,[2] with interpretations by Vidus Vidius, may be seen a large number of engravings, illustrating the complex and cumbrous machinery employed by the ancients in the reduction and treatment of fractures and dislocations of the bones. They look like the diabolical racks of the inquisition. The surgery of Oribasius is characterized by timidity; he only advised an operation in extreme cases, depending chiefly on external remedies. He is noticed in this place, to indicate the state of surgery in the fourth century—the timidity of operators, the absence of original authors, and the reliance on Hippocrates, Galen, and other eminent writers, of a previous age, set forth in compilations, commentaries, and compendiums.

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[1] While holding this office, he was sent on an important occasion to consult the oracle at Delphi, and received the celebrated response, "That henceforth forever all the oracles should be mute." (Sprengel, Hist. Med., t. ii. p. 188.)

[2] Medicæ Artis Principes, tom. ii. Paris, 1567.

We now glide down the stream of time nearly two centuries before we are arrested by another monumental writer. Aëtius (A. D. 500–550), a native of Amida, in Mesopotamia, on the banks of the Tigris, was, as he tells us, a pupil of the Alexandrian School of Medicine, from which, in that age, all physicians of note emanated. Aëtius became distinguished; he was physician to the court at Constantinople, and captain of the Imperial Guard, bearing the title of "Count of the Palace." The following, among other reasons, are furnished to show that he was a Christian. He recommends these words to be repeated for the extraction of a bone from the throat: "Bone, as Jesus Christ caused Lazarus to come forth from the sepulchre, as Jonah came out of the whale's belly, come out of the throat;" or in this form: "Bone, I conjure you by Blaises, martyr and servant of Jesus Christ, come forth or go down." His credulity was boundless. Though Apollonius of Tyana, in Cappadocia, in the first century, has been claimed as the inventor of magic cures, and the advocate of talismanic influences; yet the first introduction of charms and amulets into strictly medical writings is to be found in the works of Aëtius. Aside from all this, he compiled a treatise, much after the manner and style of Oribasius, which is a valuable repository of facts, some of which are not elsewhere found in ancient writings. It is an epitome of the works of most antecedent authors on medicine and surgery. He has the additional merit of having, himself, added to the stock of knowledge then existing. His work is almost wanting in anatomy, and yet it contains a very good description of the female generative organs. It is silent on the subject of fractures and dislocations, which has been construed into an indication that, at that time, the treatment of this class of cases was left to "natural bone-setters" and ambulatory quacks. His surgical writings, including obstetrics and gynæcology, are not only copious but valuable. They contain many things omitted by Celsus and Galen, as well as not a few that are entirely overlooked by Paul of Ægina, who succeeded him as a compiler, nearly a century later. Aëtius recommends scarifications of the legs in anasarca. He attempted to dissolve urinary calculi by the use of internal remedies; he described many affections of the eyes, not mentioned by previous writers; he differentiated several varieties of hernia, wrote on aneurism, on punctured wounds of the nerves, on diseases of the testicles, on castration, on abdominal abscess, on pelvic abscess, on all the malpositions of the uterus, on the use of the vaginal speculum, the uterine sound, sponge tents for the dilatation of the os uteri, the surgical treatment of cancer of the breast, etc. etc. He is the first medical writer who speaks of the dracunculus, or Guinea-worm. His operation for the cure of aneurism is so interesting that I cannot pass it without making some extracts from his account of it. He first speaks of the danger of operating on aneurisms which occur in the neck or head, saying:—

> For as soon as the aneurism is laid open, so large a quantity of blood and of vital spirit escapes, that the patient frequently dies in the hands of the surgeon. But surgeons treat aneurisms at the bend of the elbow in the following way: The course of the artery, from the armpit down to the elbow, along the inner side of the arm, is

> first marked out ; a simple incision is then made in a longitudinal direction for three or four fingers' breadth below the armpit, along the inner aspect of the arm, in that part where the artery is most distinct to the touch ; the vessel being then carefully exposed by dividing and separating the parts that lie above it, and being drawn up with a blunt hook, is properly tied by two ligatures, and divided midway between them. . . . The tumor in the cavity or bend of the elbow may then be safely laid open, without the fear of an effusion of blood. Having emptied out the coagula, the artery whence the blood flowed is to be sought for, and when found, being drawn up with a hook as before, is to be tied and cut across.

The account given by Aëtius of " the surgical treatment of cancer," is an extract from Leonides, of the first century:—

> In the treatment of those cancers that arise upon the breast, I rely entirely upon surgery, which is done thus : I make the patient lie upon her back, then I cut upon the sound part of the breast above the cancer, and burn in the incision with a red-hot iron until a crust is formed sufficient to arrest the flow of blood; I immediately incise again and dissect up from the deepest part of the mamma, and again burn the incised parts, and after this I repeat the cutting following it with the red-hot iron sufficient to arrest the hemorrhage. The first burning is for the arrest of the hemorrhage, but afterwards the *burning is for the removal of every vestige of diseased tissue.* But often also when the indurated cancerous tumor is situated less deep in the breast, the entire operation is performed without the cautery, for in such cases it is sufficient to amputate to the sound parts, as there is no danger from hemorrhage.

I have italicized the above words to call attention to the all-important point insisted upon by modern pathologists and surgeons, viz: " the removal of every vestige of diseased tissue." The operation of Leonides, in the first century, painful as it must have been when the priceless boon of anæsthesia was unknown, was nevertheless far more effective and radical than the mode of operation still often practised in this nineteenth century of boasted science and skill.

Aëtius also furnishes us two very interesting chapters taken from Philumenus, a distinguished surgeon and gynæcologist of the second century; one " on the causes of difficult labor," and the other " on the dissection and extraction of the fœtus." In the chapter " on the surgical treatment of abscesses of the womb" (pelvic abscess) we find the earliest directions for the use of the vaginal speculum. This is taken from Archigenes, of the first century. The directions run thus:—

> If the abscess is situated about the mouth of the womb, so that surgical treatment can be used, we should not be in haste to open it too early, but wait until the disease is perfected by the greater increase of the inflammation, whereby the parts containing the pus are thinned. And then the woman is placed supine in a chair, with her legs drawn up upon the abdomen and her thighs separated, with her arms brought down under the legs and properly secured by a cord passing over her neck ; she is then placed before a clear light, when the surgeon, seated by her right side, separates the pudenda with the speculum (dioptra) suited to the age of the patient, and makes an examination, and with a sound measures the length of the vagina so that he may not compress the uterus with the stem of a speculum longer than the vagina. And if it is found that the stem is greater than the vagina, rolls of wool should be placed upon the labia or sides of the pudenda, so that the speculum itself is made firmer. The stem should be introduced with the screw turned to the upper part; then, while the surgeon holds the speculum, the screw is turned by an assistant, so that by separating the blades the vagina is distended.[1]

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[1] I am somewhat indebted to an interesting article by Prof. Maughs, in the Journal of the Am. Med. Assoc., vol. ii. p. 225, March 1, 1884, entitled "what the ancients knew concerning obstetrics and gynæcology." In this article are to be found several extremely interesting extracts from the works of Aëtius, translated by Prof. Maughs, with judicious commentaries.

The rectal speculum was in use in the time of Hippocrates, as I have already mentioned, and it is probable that the vaginal speculum also was then in use; however, we find no direct mention of it until that of Archigenes, of the first century, as preserved in the writings of Aëtius, of the fifth. Archigenes does not speak of it as a newly invented instrument. In 1818 a beautiful and artistic bronze instrument, consisting of three branches or valves, with two handles and a central screw, an ancient *speculum matricis*, was dug out of the ruins of Pompeii, and is preserved, with other surgical instruments found at the same place, in the museum at Naples.[1]

It is a remarkable fact that the use of the vaginal or uterine speculum passed into disuse for a period of not less than a thousand years, say from the seventh to the eighteenth century. This was probably due to the influence of the Arabian school, which gained its supremacy at the time that the Moslem conquerors took possession of Alexandria, and burned its famous library by command of Omar, in A. D. 642. It was against the Mahommedan creed that women, even in their suffering, should undergo personal examination except by one of their own sex. There are many other things mentioned in the compilation of Aëtius which relate to uterine surgery: the exploring sound; the use of sponge-tents for dilating the os uteri, with threads attached for their ready removal; more than a hundred formulæ for medicated pessaries and suppositories; the use of injections, plain and medicated, of hip-baths, the douche, and fumes and vapors through tubes; the treatment of ulcers of the os, of pedunculated uterine tumors, etc. I will merely mention that he devotes one hundred and twelve chapters, long and short, to the diseases of women: thirty-seven to pregnancy, parturition, and suckling; six to various ulcerations of the womb; three to abcesses; two to displacements; two to obstructed and imperforate uterus; seven to growths occurring in the vagina and uterus; and eighteen to menstruation and its disorders. A careful study of ancient obstetrics, and particularly of ancient gynæcology, will tend to diminish our admiration of the pretentious claims of the modern revivers of these departments of operative surgery.

As an evidence of the progress which had been made in the careful discrimination of diseases from the era of Hippocrates, and even after the time of Galen, to the period in which Aëtius flourished, we find, upon a comparison of Galen with Aëtius, that the catalogue of human maladies had been augmented fully one-third. As an example, Celsus describes thirteen diseases of the eye which require surgical treatment, while no less than thirty are enumerated by Aëtius, and in one of these he describes three distinct modes of operating.

Space will not admit of any further examination of the valuable compilations of Aëtius, so with the mere mention that he is the earliest writer who speaks of the supposed medicinal virtues of the magnet, I will lay him aside. "They say that those who are afflicted with gout in their hands or feet, or with convulsions, are relieved by holding a magnet in their hands."

The last of the Greek medical and surgical writers with whom we are interested is Paul, surnamed Ægineta, from the fact of his being a native of the isle of Ægina. He flourished in the latter part of the sixth and first half of the seventh century. Paul was unquestionably a general practitioner, but especially celebrated as a surgeon and obstetrician. It is said that the Arabian midwives, who regarded him as an oracle among the women, sent great distances for him in consultation in difficult cases. The Arabian writers speak of him as "*the obstetrician*" (*Cawabely*). He has been much reviled by some, whom it is to be feared have read him too superficially, as being at best a mere compiler, and withal a sort of literary crow, taking from whence he pleased without the fairness of even an acknowledgment. This is untrue, as we find many valuable things in his works which are his own, and not elsewhere seen in previous writers; and, moreover, that he has made no secret of his plan, which was to prepare a practical treatise without reference to the sources from which the materials were derived. His own words should spare him from the reproach of plagiarism:—

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[1] For descriptions and figures of those instruments, now over eighteen centuries old, see Brit. and For. Med-Chir. Rev., vol. xxxvi. p. 178. Lond., July, 1865; Medico-Chir. Trans., vol. xxxiii. p. 261. Lond. 1850.

> While it would be extremely difficult, not to say impossible, to retain in the memory the general principles of the healing art, and all the particular means advised by the ancients, I have made this abridgment of what there is best of their writings. They are not my own conceptions which I propose, if exception be made of some details of observation noted in my practice; but being versed in the reading of a number of excellent authors, and principally Oribasius, I have attempted, in imitation of him, to collect the cream of what others have said concerning the means of preserving health.

This is certainly a modest avowal, and yet Paulus Ægineta was an author of more originality than either Oribasius or Aëtius. His sixth book has been considered by many, and not without reason, as the best body of surgical knowledge, previous to the revival of letters. Here we find many things not elsewhere found in any surgical writings previous to his era. Paulus was himself a practical surgeon, bold and skilful, governed by experience and judgment, and not a mere servile follower of antecedent authority. Thus we find him questioning the methods of even Hippocrates and Galen, and often referring to his own personal experiences, and to the results of his cases and operations.

He was a strong advocate of local blood-letting; he mentions but disapproves of a three-bladed scarificator then in use, and also mentions cups of glass, brass, and horn. He resorted freely to arteriotomy. He opened deep-seated abscesses by caustics, and laid down careful rules for the performance of paracentesis in the several varieties of dropsy. In lithotomy he made great advances on the restricted methods of Celsus. Instead of confining the propriety of the operation to the age of puberty, that is, from nine to fourteen years of age; he approves of its performance at any period of life, saying: "Of those cut for the stone, children to the age of fourteen are the best subjects for the operation, on account of the softness of their bodies; old men are difficult to cure because ulcers of their bodies do not readily heal; and the intermediate ages have an intermediate chance of recovery." Then follows a remark which is ingenious, though not confirmed by experience: "And again, those who have larger stones recover best because they have become habituated to the inflammation," or vesical irritation, which the presence of the calculus occasions. Celsus directs that the incision should be made in the line of the perineal raphe, while Paulus says, "we take the instrument called a lithotome, and between the anus and the testicles, not, however, in the middle of the perineum, but on one side, towards the left buttock, we make an oblique incision, cutting down direct upon the stone where it protrudes, so that the external incision may be wider, but the internal not larger than just to allow the stone to fall through it." He mentions a special forceps for the removal of the calculus; when "it does not start out itself, we must extract it with the forceps called the stone-extractor."

Paulus also extends the limits in operations for the radical cure of aneurism. While Aëtius would advise that aneurisms of the arm alone should be treated by operation, Paulus includes those of the head and joints, excepting only those of the cervical, axillary, and inguinal regions. He is the first who pointed out with clearness and accuracy the nature and diagnosis of aneurism by anastomosis. The only description of the operation of tracheotomy to be found in the Greek authorities is that given by Paulus, who says that it is taken from Antyllus, of the third or fourth century. Aretæus mentions the operation with disapproval. Cælius Aurelianus says that Asclepiades performed it in cases of cynanche (probably croup), but he himself does not favor it. Paulus, in his remarks "on laryngotomy,"[1] says:—

> The most famous surgeons have also described this operation. Antyllus, therefore, says, "in cases of cynanche we entirely disapprove of this operation." . . . "When, therefore, we engage in the operation we slit open a part of the arteria aspera (for it is dangerous to divide the whole) below the top of the windpipe, about the third or fourth ring. For this is a convenient situation, as being free from flesh, and because the vessels are placed at a distance from the part which is divided. Wherefore, bending the patient's head backwards, so as to bring the windpipe better into view, we are to make a transverse incision between two of the rings, so that it may not be the cartilage which is divided, but the membrane connecting the cartilages. If one be more timid in operating, one may first stretch the skin with a hook and divide it, and then, removing the vessels aside, if they come in the way, make the incision." These are the words of Antyllus. We judge that the windpipe has been opened from the air rushing through it with a whizzing noise, and from the voice being lost. After the urgency of the suffocation has passed over, we pare the lips of the incision so as to make them raw surfaces again, and then have recourse to sutures, but sew the skin only without the cartilage. We must follow the same plan of treatment if we should meet with the case of a person who had cut his own throat from a wish to commit suicide.

There is no mention made of fracture of the patella in the works of Hippocrates or of Celsus. Soranus merely gives the symptoms, hollowness and crepitus in the part. Paulus is the first to describe it and direct the treatment:—

> The symptoms are obvious, a solution of continuity, a hollow, and crepitation. The fracture is put in order by extending the leg, for thus the divided portions may be brought together with the fingers, until the lips of the fracture mutually touch, and are united to one another, and fractured pieces, when separated, are thus arranged together. For even if callus does not form, owing to the parts being drawn in different directions by the muscles and tendons from the thigh and leg, which are inserted into it, yet the separation is much diminished.

We find in Paulus a very curious and interesting chapter (Sect. lxxxviii.) on the means of extracting arrows and other weapons from various parts of the body, and also a description of the multiple forms of penetrating weapons then in use. Paulus quotes these lines from Homer:—

> The man of medicine can in worth with many warriors vie,
> Who knows the weapons to excise, and soothing salves apply.

> Warlike instruments, then, differ one from another in material, figure, size, number, mode, and power. In material, then, as the shafts are made of wood or of reeds; and the heads themselves are either made of iron, copper, tin, lead, horn, glass, bones, and of reeds, too, or of wood; and such differences are found especially among the Egyptians. In figure, inasmuch as some are round, some angled (or triangular), some pointed and lance-shaped, as some have three points; some are barbed and some are without barbs; and of the barbed, some have the barbs turned backwards, so that in attempting to extract them they fasten in the parts; and some forwards, so that when pushed they may do the same thing; some have them diverging in opposite directions like the forked lightning, in order that when pulled or pushed they may fasten into the parts. Some missiles have their barbs united by a hinge, which being expanded in the extraction, prevents the weapon from being drawn out.

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[1] De re medica, lib. vi. sect. xxxiii.

He speaks of various instruments used in the extraction of these missiles, such as "tooth-extractors," "root-extractors," "the impellent instrument," "the trephine," when the missile is fixed in bone, etc. Paulus says: "Some apply a tube about the barbs, so that when they draw out the weapon the flesh may not be torn by the barbs." There are many other things contained in this chapter which will amply repay perusal. I shall, however, refer only to his use of the ligature for the arrest of hemorrhage. "But if the weapon has lodged in any of the larger vessels, such as the internal jugulars or carotids, and the large arteries in the armpits or groins, and if the extraction threaten a great hemorrhage, they are first to be secured with ligatures on both sides, and then the extraction is to be made."

Hippocrates and Celsus both wrote on the extraction of weapons, but neither as fully as Paulus, from whom almost all subsequent writers, and notably the Arabians, quoted nearly verbatim.

Paulus wrote on the various forms of intestinal hernia, in an ample, accurate, and precise manner. His directions for operating in strangulated hernia are more clear and minute than those given by Celsus.

Paulus Ægineta may have been still living when the Saracens captured Alexandria in the year 640, and may have lamented with inexpressible sorrow the flight of learning into Arabia and Persia, whose peoples were to become enlightened through the medium of translations of the Greek authors, and who were, for many long and dreary centuries, to be the sole conservators of all scientific knowledge, while Europe was to be wrapped in intellectual darkness; as

> "One vast eclipse the human mind o'erspread,
> And learning slumbered with the mighty dead."

The Arabic period, which commenced at the destruction of the Alexandrian library, as above stated, continued to the close of the fourteenth century, or about six hundred and sixty years. Notwithstanding that the mass of the great library of Alexandria was burned to ashes, yet enough was rescued from the ruthless flames, by the lovers of literature and science, to furnish abundant material for Honain and his associate translators, for many years after, to convert into the Syriac and Arabic languages, by which mediums it was dispersed throughout western Asia. And so it came to pass that "the seat of learning was transferred for a time, from beneath the shadow of the cross to the empire of the crescent; from the classic shores of Italy and Greece to the warlike followers of Mahomet, and the fiery descendants of Ishmael."

The surgery of the Arabians is the surgery of the Greeks, with such modifications, by way of interpretations, as would be likely to result in passing from the tongue of one nationality to that of another. And since there is so little to be found that is original in the surgical writings of the Arabians, it will only be necessary, in a brief historical sketch like this, to cursorily review the works of a few of the most distinguished of the Saracenic surgeons of the dark ages.

The first Arabic translation was made about the year 683, but the principal part of this work was done by Honain, "the translator," in the latter part of the eighth century. About this time the Caliph Al-Mansoor founded a college in Bagdad, which, under the continued care and patronage of the Caliph Haroun-al-Raschid—of delightful memory,—became a famous centre of intellectual illumination, a star in the east. Bagdad could then boast of its public hospitals and laboratories, and its many thousands of students in the several departments of art and science.

Rhazes, a celebrated Arabic medical writer, was born in Persia, and flourished in the latter part of the ninth and the early part of the tenth century (852–932). He was thoroughly educated to the profession, having been the chief of an immense hospital at Bagdad, having also travelled into many lands, the better to acquaint himself with all diseases, and being well versed in the literature of the healing art. While it is not probable that he had ever dissected the human body, still some nice anatomical points are noted in his works. In treating of the operation for fistula lachrymalis, he cautions against wounding the external or anterior branch of the ophthalmic nerve—a branch not mentioned by any of the Greek writers—and in modern times particularly pointed out by Willis. Blood-letting was in vogue in the days of Rhazes; he describes all the four methods, viz., venesection, arteriotomy, cupping, and leeching. He is the first to describe all the varieties of the leech, with directions for their preservation, use, and mode of application. Rhazes has much to say concerning resection and exsection of diseased bones, and goes so far as to remove the entire tibia, or the os brachii, when they are carious, but forbids meddling with the head of the femur or the vertebræ. In fact, the entire field of surgery and the whole range of surgical operations as taught by the Greeks and Romans were adopted by the Arabians. Rhazes's directions for the use of the catheter are more minute and ample than those of any previous writer. He is the first to say that it is best to have openings in the sides of the catheter, as being less likely to be obstructed by clots. He also mentions that he in some cases used a ductile catheter, made of lead, which accommodated itself to the urethral passage; and, that in still more difficult cases he resorted to puncture of the bladder. As an evidence of his personal experience, he tells us that he had successfully treated a thousand cases of sciatica by bleeding freely from the veins of the leg, and by the use of sharp clysters. Rhazes was the first to describe spina ventosa and spina bifida. He also wrote an entire treatise on the diseases of children.

It is not to be understood that surgery in the days of Rhazes was generally practised with the skill which the works of this eminent practitioner taught. On the contrary, he was a shining light, while the art, for the most part, was in the hands of ignorant men and downright impostors; in fact, he wrote a chapter "of impostors,"[1] to show the degraded character of surgical quacks, and as a caution to the public against their malpractice. He also wrote a chapter on the selection of a proper physician, in which he says: "Study carefully the antecedents of the man to whose care you propose confiding all you have most dear in the world; that is to say, your health, your life, and the health and lives of your wife and children."

It is certain that lithotomy, and probable that many other operations, were almost exclusively in the hands of itinerant and unprincipled impostors.

Haly Abbas flourished during the latter part of the tenth century (930–994). He too was born in Persia, and dwelt most of his time in Bagdad. His works, written in Arabic, exercised a long and potential influence in mediæval times. He collected a large number of observations from his extensive experience in hospitals, and laid it down as the cardinal requisite of all young physicians, to avail themselves of the clinical advantages afforded by those institutions. Here, he remarks, they will see diseases in their true light, which the books describe in a manner little approaching to nature.

He approves of excision of strumous glands, and describes the mode of operating. In cases of distended bursæ mucosæ, or ganglions, as Haly Abbas calls them, he first uses discutients, and if these fail to cure, then he would strike the tumor with a hard body, so as to break the cyst.[2] Thus it is seen that this procedure has the sanction of no less than nine centuries. In dropsies Haly disapproves in general of paracentesis. He says that he never saw it performed but once, and that then it failed to save the patient. He adds that Galen relates that he knew of but one case in which it had proved successful. Haly tells us to select a point, about three fingers' breadth below the navel, in the linea alba. In enlargements of the liver, or the spleen, the puncture is made on the side opposite the diseased organ.[1] In hydrocele, he directs us to open the tumor and dissect out its tunics, and then to apply incarnative dressings. This treatment, he adds, the *moderns* prefer to the escharotic applications used by the ancients.[2] In cases of imperforate pudendum, whether congenital or the result of disease, Haly gives directions for an operation to be performed by a midwife. The delicate sense of the Arabians would seldom permit a man to perform a surgical operation about the genital organs of a woman.[3] In imperforate anus, Haly directs us to make an opening, and introduce a piece of sponge or a leaden tube to prevent its closure. When an artery has been wounded in bleeding, the surgeon is directed to dissect away the surrounding parts, and, having applied a silk thread on each side of the wound, to divide the artery in the middle. In aneurism Haly makes a longitudinal incision, exposes the tumor and the vessel on each side of it, passes beneath the vessel a needle armed with a double ligature, ties it above and below, and lays open the sac and evacuates its contents. In fractures of the lower jaw, Haly advises that the teeth should be secured together with a ligature, before using compresses or bandages. He gives good directions for making splints of certain kinds of wood, shows how to avoid placing them over processes of bone, and forbids their use in fractures where inflammation is present.

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[1] Lib. ad Almansorem, lib. vii. cap. 27.

[2] Lib. totius Med., etc., Pract., lib. ix. cap. 10.

The above are a few selections from the surgical teachings of Haly Abbas; the body of his work is a repetition of the surgery of previous ages. He quotes much from the Greeks, and generally acknowledges the sources from which he has drawn his material. A perusal of his work will satisfy the reader that the principles and practice of surgery were fairly well understood in Arabia and Persia during the tenth century.

The next surgical authority who in the order of time claims our attention, is Avicenna, surnamed the Prince of Physicians (980–1037). The *Canon* of Avicenna was to the healing art, for a period of over five hundred years, what the Koran was, and is, to the followers of the prophet of Islam. The works of Hippocrates, the vast medical commentaries of Galen, and the writings of Avicenna, have exercised a greater and a more continued influence over the minds of medical men than any and all other authorities the world has ever produced. The classic works of this immortal triumvirate were, for many ages, the great store-houses of facts and observations, as well as the oracles, the code, the judicial authorities in everything that related to the nature and cure of all human maladies. The Canon of Avicenna accompanied the armies of the Crusaders, and was still used as a text-book in the Universities of Louvain and Montpellier as late as the year 1650, or thereabouts. The multiple editions of this work which appeared after the art of printing was established, attest the immense popularity which it enjoyed in Europe from the fifteenth to the close of the seventeenth century.

Avicenna, in common with all the Arabic surgical writers, drew largely from the works of his predecessors, adding some personal experiences, and much obscurity in the way of commentary. He was very partial to the use of the actual cautery, and employed it freely in many diseases. Cancer of the breast was treated by three methods: By corrosive applications, by burn-ning irons, and by excision with the scalpel, followed by the actual cautery. The object of the cautery was twofold, viz: the arrest of hemorrhage and the eradication of the disease.

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[1] Ibid., lib. ix. cap. 41.

[2] Ibid., lib. ix. cap. 47.

[3] Ibid., lib. ix. cap. 66.

One of the most interesting things found in the works of Avicenna, is his mention of the *obstetric forceps*, which is the earliest reference to that instrument in any of the ancient treatises. Difficult labor is treated of by this author in a very exhaustive manner. In some cases of difficult delivery—owing to the large size of the child—he directs us to apply a fillet around the child's head and endeavor to extract it. When this fails the forceps are to be applied, and the child extracted by them. If this cannot be accomplished, the child is to be extracted by incision, as in case of a dead fœtus. This passage furnishes unmistakable proof that the Arabians were acquainted with the method of extracting the child alive by the obstetric forceps. All the forceps mentioned and figured by Albucasis have teeth, and were only intended for the delivery of the fœtus when dead.

Fistula in ano was treated, from the earliest times, by ligature, and also by incision. Avicenna preferred to silken or hempen thread, as a ligature, twisted hairs or bristles of the hog, as they were less likely to rot or putrefy. We would now say more antiseptic. He speaks favorably of refracturing bones which have united with much deformity. Thus it is seen that surgery was still fairly understood by the Arabians in the early part of the eleventh century.

Another century brings us to the time when surgery was taught in western Europe, particularly in Moorish Spain, by the celebrated Albucasis and his immediate successor Avenzohar. Albucasis was born near Cordova about the year of Grace 1060, and probably died in 1122. He informs us that in his time surgery was in a most deplorable condition. It was on this account that he determined to write his work on surgery, which is a small treatise, being a sort of supplement to his greater work on the theory and practice of medicine. This fragment is considered to be one of the most curious and valuable monuments of Arabian medicine. The following are the reasons, as given by himself, which induced him to prepare his "*De Chirurgia*," or "Al-Tasrif," which is the Arabic word for "The Art of Healing."

> After having terminated, happily enough, the work on medicine which I undertook for your instruction, my sons, I have thought it proper to add to it a small treatise on manual operations, seeing that this part of our science is so much neglected in our country at the present time, that there remain scarcely any vestiges of it. We can only find a few short descriptions of operations in the books of the ancients; they are, however, disfigured by the ignorance of the bookmakers; the manuscripts are so faulty that at every step we are in such doubt as to the sense of the authors, that no one dare enter into the study of surgery. I have, therefore, undertaken this little treatise for the purpose of reviving this most important and useful branch of our art. I have detailed briefly the methods of operation, I have described all the necessary instruments, and I present their forms, by means of drawings; in a word, I have omitted nothing of what can shed light on the practice. But one of the principal reasons why it is so rare to meet a skilful surgeon is, that the apprenticeship to this branch is very long, and he that devotes himself to it must be versed in the science of anatomy, of which Galen has transmitted us the knowledge. He should know the functions of organs, their shape, and their relations; the number of the bones, and their modes of union; the origin and termination of the muscles, the nerves, the arteries, and the veins. In fine, no one should permit himself to attempt this difficult art without having a perfect knowledge of anatomy, and of the action of remedies.[1]

There are good reasons for considering Albucasis and Alzaharavius to be one and the same surgical author. The earliest figures or drawings of surgical instruments of which we have any knowledge, are those to be found in the original manuscripts of the treatise of Albucasis. This treatise is divided into three books. The first is devoted to the diseases which were considered curable by the use of the cautery—actual and potential—and the modes of application. This was his favorite remedial agent. He enumerates not less than fifty diseases in which he had observed its utility. It was a favorite practice with all the Arabians to roast the flesh of their patients. Freind observes of Albucasis, "he seems to be in a rapture in speaking of the divine and secret virtues of fire." Many ages before his time, Dioscorides, the contemporary of Celsus, spoke of the use of the actual cautery as the "Arabian burnings." The second book comprises all that relates to operations which are to be performed with cutting instruments. It describes ninety-seven operations requiring the knife. The third book is devoted to the treatment of fractures and dislocations of the bones. Albucasis tells us that this branch of surgery had unhappily fallen into the hands of the most ignorant pretenders, who were looked upon with suspicion and contempt.

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[1] De Chirurgia, lib. i.

Albucasis assures us that his work is founded upon extensive reading and large personal experience, and that he has written nothing that he has not witnessed in his own practice; and yet the work is little more than a fair exposition and an epitome of the principles and practice of Arabian surgery as taught by his predecessors. There is no other work of this period, however, that is at all comparable with it in general completeness, richness of detail, and lucidity in description. Indeed, it may truly be esteemed as one of the most precious relics of the healing art which have been transmitted to us from mediæval times.

Albucasis treats of many surgical affections of the eyes: of trichiasis, eversion of the eyelids, lipoma of the lids, encanthis, pterygium, staphyloma, hypopyon, fistula lachrymalis, and cataract. In cataract he advises operation by depression, and gives drawings of the couching-needles, called by him "*almagda*." He mentions that he had heard of a certain oculist who, it was said, sucked out the cataract (*lens*) through a small tube. He adds, however, that he had never seen this operation performed, nor had he read of it in any of the works of the ancients.[1] Rhazes accurately describes the operation of couching, extraction, and sucking out the cataract.[2] The subject of dental surgery is nowhere so fully treated in the works of the ancients as it is in the "De chirurgia" of Albucasis. Space will not allow me to give details of extraction, treatment of caries, fastening loose teeth by gold wire, etc.

He excised the uvula and tonsils, by the aid of a tenaculum and scissors. In the removal of large adenoid tumors he advises the ligation of the principal nutrient artery. In tumors of doubtful character he advises an explorative puncture to determine the nature of their contents or structure. Besides the treatment of aneurism by ligation above and below, and opening the sac, he speaks of the cure of some cases by the use of compresses and tight bandaging. Much is said in his work on the various modes of abstracting blood: venesection, arteriotomy, cupping, and leeching. Empyema was treated by actual cautery and puncture between the ribs; sometimes the pointed cautery was passed directly into the pleural cavity. He tells us that he never saw a case of cancer cured by excision, unless it was both recent and small. Abscess of the liver was opened by a spear-shaped actual cautery. He discourses on many other subjects—quite fully upon amputation of the limbs. The imperfect state of surgery in the time of Albucasis, and his own timid practice, are illustrated by a case which he relates. A person who had a spreading mortification in the foot, cut the limb off himself at the ankle-joint, and was cured for the time. The disease next attacked the hand, upon which he applied to Albucasis, requesting that he would cut off the part in the same manner; but this he refused to do, for fear that the man's strength might not be able to endure the operation. He afterwards learned that the patient had cut off his whole hand, and had recovered.[1] He treated fractures of the femur with the long splints; and exsected sharp points of bone and spicula. He speaks of four methods of reduction of dislocations of the hip-joint. The first was by rotating the limb in all directions. Was not this reduction by manipulation? In all surgical cases he exhorts the surgeon to act with caution, but with confidence, assuring him that such conduct will prove most pleasing in the sight of his Creator, as well as redound to his own glory. The works of Albucasis were held in very high estimation by the early modern writers on surgery, as we find them extensively quoted by Guy de Chauliac, Theodoric, Brunus, Gulielmus de Saliceto, and others, down even to the time of Fabricius of Acquapendente. Not less than five and twenty editions have been printed, from the earliest at Venice, in 1471, to the latest at Oxford, in 1778.

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[1] De Chirurg., lib. ii. cap. 23.

[2] Lib. ad Almansorem, lib. ix. cap. 27; Lib. Cont., lib. ii.

Avenzohar was born in the city of Seville, the magnificent capital of Andalusia, about the year 1070, and died in 1161. This celebrated Saracenic physician, surgeon, and pharmaceutist, for he combined the three professions, as he himself tells us, though quite contrary to the existing custom of the period, is said to have been the most illustrious writer and practitioner of the healing art that had flourished since the renowned Avicenna. His distinguished pupil, Averroës,[2] looked upon him as almost a divinity in medicine, and poured upon him unmeasured praise; as many passages in his works will verify, calling him his "admirable Master," "the glorious," "the treasury of all medical knowledge," "the supreme of physicians from the days of Galen" to his own time. The father, and grandfather of Avenzohar were eminent physicians, and thus it would appear that he almost inherited his profession.

Avenzohar treats of fractures and dislocations in a way that indicates no inconsiderable amount of precise anatomical knowledge. Indeed, he tells us: "I took great pains, when I was young, to understand the situation of the bones and their connection one with another; and not only to be acquainted with, but with my own hands to perform operations, and this with a very great eagerness and appetite for the thing itself, as husbandmen and huntsmen are delighted with the exercise as such. I was rather fond of this knowledge, because some time or other it might be of use to myself or my friends, or to the poor." His works contain some very interesting cases: among others, a case of abscess of the kidney, or entire disintegration of that organ, the capsule only remaining, and this being so much distended as to contain seven quarts of purulent fluid. He describes the symptoms and result of a case of abscess of the mediastinum, which occurred in his own person. This is said to be the first recorded case of the kind. In an after age, both Columbus and Barbette treated mediastinal abscess successfully by trephining the sternum. Avenzohar also gives a lucid account of purulent collections in the pericardium, and of obliteration of the pericardial sac by adhesion of its walls.

None of the Arabian surgical authors speak as approvingly of the operation of bronchotomy as does Avenzohar. He believed it to be justifiable in desperate cases of quinsy, under which term, in that day, croup and all inflammatory diseases of the throat were included. He admits, however, that he had never seen it done, and that he had never attempted it, but, with the view of satisfying himself that it was a practicable operation, he had made an experiment on a goat, cutting an opening through the tracheal rings, and found that the wound was readily healed. Avenzohar was called "The Experimenter." The most interesting observations recorded by this author relate to artificial methods of alimentation in cases of inability to swallow food. He proposes three modes. The first is to introduce an œsophageal tube, made of silver or of tin, as far down as it will readily pass, and through this pipe to pass milk or other thin nourishment into the stomach. This method—the immediate forerunner of the stomach-tube—is not previously mentioned by any author. The second expedient is the use of nutritious baths, such as those of milk, etc., this mode of feeding depending on cutaneous absorption, of which he had a poor opinion. The third mode, that of rectal alimentation, of which so much is said at the present time, he regarded as of extreme utility, although the almost unquestionable authority of Galen was against it. Oribasius[1] wrote an entire chapter on clysters.

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[1] Op. cit., lib. ii. cap. 89.

[2] Colliget, fol. 30, 39, 52, 56, 64.

Avenzohar recommends the use of the trephine in cases of fracture of the cranium, with depression. He laments that in his time it was difficult to find a surgeon capable of performing the operation. Averroës gives the same testimony. It is evident that the Arabian surgeons of mediæval times were timid operators.

The first attempt to diminish the size of a calculus impacted in the urethra is described in the works of Avenzohar.[2] After having given directions for extracting a calculus from the urethra, he proceeds to teach the manner of breaking, or, as is most probable, of grinding it down, by an instrument which would appear to be a sort of drill, which he describes as "a thin polished rod, made of gold or silver, and having a pointed adamant enchased in its extremity." This is the earliest progenitor of the *lithotrite*, and marks the beginning of lithotrity. In treating of the best means of relief for persons suffering from the presence of stone in the bladder, he expresses his utter disgust at the operation of lithotomy, as being opposed to the principles of his religion, which forbids the scrutiny of a part of the body too unclean to be seen with the pure eyes of the faithful. He styles the operation filthy and abominable, and unfit for any man of character to perform. His fastidiousness does not, however, prevent him from describing this and other operations upon the genitals.

Averroës of Cordova (1126–1198), another Spanish-Arabian physician, the famous commentator on the philosophical works of Aristotle, the founder of a system, "Averroist Aristotelianism," the eminent jurist, the honored governor, the debased philosopher, the "impious and thrice-accursed Averroës," flourished from the middle to the latter part of the twelfth century. He wrote treatises on the healing art which are still extant, but, properly, he has no place in the history of surgery.

Here endeth what space will admit of being said concerning the Arabians. The influence of their medical and surgical writings continued to be felt during several succeeding ages, even as recently as the seventeenth century. Their works appeared in numerous editions soon after the art of printing was invented. The medical schools of all Europe stamped them with authority and employed them as text-books; their professors translated, annotated, interpreted, and illustrated them; and all the students of our art waded diligently through these ponderous black-letter folios, and drank deeply from these fountains of knowledge and wisdom.

The "School of Salernum" deserves a passing notice in the history of surgery. Historians are at variance as to the time of its foundation as a medical school. Thus we find it stated that it was originated by the fugitives from Alexandria, on the capture of that city by the Saracens, A. D. 640. Again, that it was founded by Charlemagne in the year 802. Perhaps we shall be unable to approximate nearer to the truth than by saying that physicians, and even medical teachers, flourished at Salerno as early as the seventh century, but that the establishment of a regularly organized school of medicine was brought about by the Benedictines of Monte Casino, in the ninth or early part of the tenth century. In the year 984, Adalberon II., Archbishop of Verdun, visited Salernum in order to be treated for stone in the bladder. We are only told that the result was fatal. The earliest medical treatises which emanated from this school date back to about 1035–40. In these there is no evidence of an acquaintance with the medical science of the Arabians. Galen, Oribasius, and Aëtius were the principal sources from which they were compiled. At about the close of the eleventh century, Peter the Hermit aroused all Europe by his vehement preaching, the Crusade resulted, vast armies or rather swarms of religious zealots and fanatics pushed on to the Holy Land, sharp and deadly conflicts ensued, wounds numberless were inflicted, and as Salernum, a famous medical and surgical resort, lay in the line of pilgrimage between the west and east, it was most natural that the leading Crusaders who were disabled by wounds should resort thither to obtain the benefits of renowned physicians and surgeons. Robert of Normandy, eldest son of William the Conqueror, on his return from the Holy Land, being afflicted with a fistulous ulceration of the arm, resulting from a poisoned arrow-wound received at the siege of Jerusalem, A. D. 1099, betook himself to Salernum, where his beautiful bride Sybilla, as the romantic tales relate, drew the poison from his wound with her own lips, when her husband was unconscious during sleep, and thus saved his life. While Robert was at Salernum, William II. (Rufus) died, and the throne of England was soon after occupied by Henry, the younger brother of this distinguished patient.

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[1] Collect., lib. viii. cap. 34.

[2] Theisir, lib. ii., tract. 4, cap. i.

During the sojourn of Robert at this famous sanitarium, or, perhaps, as he was about to quit it for England, John of Milan, who we are told then presided over the medical faculty of Salernum, is presumed to have written the health-poem which was destined to become so famous, to survive so many centuries, to be transmitted by numberless transcripts and manuscripts until the printer's art should be invented, and then in many languages, and in not less than one hundred and fifty editions—and some add a hundred more to these—to be scattered broadcast over the land, and to be floated down the stream of time to the present moment. The fame of this poem is truly wonderful. It is little more than an epitome of rules of diet, regimen, and hygiene, as understood in that day. Many of its wise saws are still repeated in the identical words of the poem, though few are aware of their origin and antiquity. The poem is known by many titles, *Regimen Sanitatis Salerni; Schola Salernitana; Medicina Salernitana; De Conservanda Bona Valetudine;* "Regimen," "Regiment," "Code of Health," etc. It was for ages the institute of the medical student and the text-book for learned professors. It was subjected to emendations and annotations, and was enlarged by exhaustive commentaries and erudite scholia. The school of Salernum seems to have added nothing to the previously existing knowledge of surgery, and has no interest or relation to the history of its science and art, excepting the mere fact that this was the earliest centre of medical instruction, in mediæval times, where a knowledge of the ancient medical authors was taught, and a radiant point from which the science of the Greeks and Arabians was diffused in western and southern Europe, having been conserved and distributed by our own profession, quite independently of monasteries and clergy.

Perhaps this is as good a place as can be found to introduce a few words concerning the surgery of the Asiatics, or more particularly of the ancient Hindoos. It appears evident from the careful investigations of Wilson,[1] Royle,[2] and Wise,[3] that a considerable degree of knowledge relating to all branches of the healing art already existed among the Hindoos and other Orientals, long antecedent to the period when it was possible for them to have acquired any learning or skill from the Arabians or from the Greeks.

> It is very clear, writes Prof. Wilson, that the *Charaka* and *Susruta*, the treatises called *Nedan*, and other *pourans*, treating of medicine, surgery, the diseases of women, and therapeutics, were translated from the Sanscrit, and studied by the Arabs in the days of Harun and Mansur, either from originals or probably from translations made at a still earlier period into the language of Persia. Prof. Wilson concludes that the astronomy and medicine of the Hindoos was cultivated by the Arabs of the eighth century, previous to their studying the works of the Greeks.

The *Susruta* is an ancient treatise which is almost exclusively devoted to the surgery of the Hindoos. From this we are informed that a knowledge of anatomy was regarded as important to both the physician and the surgeon. It says: "A holy man should dissect, in order that he may know the different parts of the human body; and a surgeon and physician should not only know the external appearances but the internal structure of the body, in order to possess an intimate knowledge of the diseases to which it is liable, and to perform surgical operations so as to avoid the vital parts." It was considered to be an unclean thing to touch a dead body, yet this was no great barrier to the study of anatomy, since Manu, one of the Hindoo sages and a great legislator, says: "One who has touched a corpse is made pure by bathing;" and again: "Should a Brahmin touch a fresh human bone he is purified by bathing; and if there be not water, by stroking a cow, or by looking at the sun, having sprinkled his mouth duly with water."

Having selected a proper cadaver, the person not having died from poisoning, protracted disease, or old age—

> The dejections are to be removed, and the body washed and placed in a framework of wood, properly secured by means of grass, hemp, sugar-cane reeds, corn-straw, pea-stalks, or the like. The body is then to be placed in still water, in a moving stream, where it will not be injured by birds, fish, or animals. It is to remain for seven days and nights in the water, when it will have become putrid. It is then to be removed to a convenient situation, and with a brush, made of reeds, hair, or bamboo-bark, the surface of the body is to be removed so as to exhibit the skin, flesh, etc., which are each in their turn to be observed before being removed. In this manner, the different corporeal parts of the body will be exhibited; but the life of the body is too ethereal to be distinguished by this process, and its properties must therefore be learned with the assistance of the explanations of holy medical practitioners, and prayers offered up to God, by which, conjoined with the exercise of the reasoning and understanding faculties, conviction will be certainly obtained.[4]

After such a course of practical anatomy one would hardly expect a very advanced state of surgical science and art.

The Hindoo surgeons placed great reliance on the use of the actual and potential cauteries. The former was employed in the form of hot sand, boiling fluids, combustible substances like our modern moxas, live coals for serpent-bites, hot needles, bronze and iron bars and plates. The potential cautery consisted generally of potash, which was used in opening abscesses. They had four remedies for the arrest of hemorrhages, viz., astringents, ice, caustics, and the actual cautery. The ancient Hindoo surgeons were bold, hazardous, and expert. They performed cystotomy, lithotomy, embryotomy, autoplastic operations, couching for cataract, paracentesis of chest and abdomen, etc., quite in contrast with the almost total extinction of surgery which prevails at the present time throughout India and China. In amputation of the extremities, which was done in extreme cases, the stump was first dressed with boiling oil, in a cup-formed bandage, and afterwards with pitch, vegetable decoctions, etc. Cupping and leeching were favorite remedies in various diseases.

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[1] See Prof. Wilson's remarks on the Indian physicians at the court of Bagdad (Journal of the Royal Asiatic Society, vol. vi. p. 105).

[2] An essay on the Antiquity of Hindoo Medicine, etc., 8vo. London, 1837.

[3] Review of the History of Medicine, 2 vols. 8vo. London, 1867. The above-mentioned works, with Kerr's little treatise on medicine in China, republished from the N. A. Medico-Chirurgical Review for March, 1859, furnish very interesting and ample sources of information on the subject of the history of medicine and surgery among the Asiatics, both ancient and modern.

[4] Wise, op. cit., vol. i. pp. 131–133.

Of surgical instruments the Hindoos had a very respectable armament, two hundred being described in their works. Of these, they say, "the first, best, and most important of all surgical implements is the hand." The *Susruta* describes twenty ancient cutting instruments, including knives, lancets, trocars, cutting-nippers, scissors, saws, etc. There are one hundred and one blunt instruments; twenty varieties of tubular instruments of different sizes and shapes, including catheters, syringes, etc. There are twenty-eight kinds of probes, rods, and sounds, varying in size and shape, for examining the size and nature of foreign objects lodged in parts difficult of access, and for clearing canals, particularly the urethra. Add to these various kinds of forceps, bandages, splints, etc., and it will be seen that the ancient Hindoos had no lack of surgical implements. "The *Sastras*, or cutting instruments, were of metal, and should be always bright, handsome, polished, and sharp, sufficiently so, indeed, to divide a hair longitudinally."

Lithotomy was performed by these Hindoo surgeons, generally by "cutting on the gripe," though the supra-pubic, or high operation, was sometimes resorted to. If considered specially dangerous, the latter operation was performed on women by their husbands. The removal of the stone was effected with an iron scoop. The *Susruta* also gives a description of the operations of gastrotomy, gastrorraphy, and gastro-hysterotomy (Cæsarean operation), herniotomy, rhinoplasty, etc. Rhinoplasty is a very ancient operation in Asia. The "Indian method" takes the required skin from the forehead; in Hindostan it was sometimes taken from the cheek. The Hindoos adopted a very simple and excellent device to form the nares, by the introduction of two wooden canulæ, which permitted breathing, and gave support to the nose.

In fractures of the bones they used an admirable splint, consisting of small thin slips of bamboo, bound together with strings, after the manner of old-fashioned Venetian window-shades. These possessed the excellent qualities of strength, lightness, proper flexibility, and cleanliness. The Medical Department of the British Army adopted a modification of this splint, known as "Duncan's patent rattan cane splint." Pulleys were used to reduce some kinds of dislocations.

Thus it is seen that the ancient Hindoos—by ancient I mean previous to the middle of the eighth century—possessed a valuable amount of knowledge and skill in surgery. But long before the British occupation of Hindostan and India, surgery, in these countries and also in China, was almost unknown. Anatomy was extinct, and the few operations which were done were performed by ignorant itinerants, scarcely any surgical instruments being in use. Fractures and dislocations were allowed to go without treatment, and dentistry was reduced to the extraction of teeth with the fingers. Space restricts me from entering more fully into the history of surgery among the Asiatics.

Medicine and surgery were usurped by the priesthood during the greater part of the dark ages. The monks drove a thriving and lucrative business for centuries, by combining the medical and ecclesiastical professions. Their ignorance was only equalled by their cupidity and venality. The Popes and Holy Councils had a hard struggle for more than a hundred years, in their efforts to emancipate medicine and surgery from the grasp of mercenary monks and priests who had formed this miserable alliance, and who had maintained their hold for so many ages after their invasion of the profession to which they had no claims, and for which they had no scientific affinity or adaptability. The Lateran Council, under Pope Calistus II., A. D. 1123, forbade their attendance at the bedside of the sick, otherwise than as ministers of religion. Again, Innocent II., in a council at Rheims, A. D. 1131, enforced the decree prohibiting the monks attending the schools of medicine. The pertinacity of the priesthood, however, obliged the Lateran Council, in 1139, to threaten all who neglected its orders with the severest penalties; "neglecting the sacred objects of their own profession, and holding out the delusive hope of health in exchange for ungodly lucre." At Tours, in 1163, the Council, under Pope Alexander III., again stigmatized and denounced these priest-physicians. "In 1215, Innocent III. fulminated an anathema specially directed against surgery, by ordaining that, as the church abhorred all cruel or sanguinary practices, no priest should be permitted to follow surgery, or to perform any operations in which either instruments of steel or fire were employed; and that they should refuse their benediction to all those who professed and pursued it."[1]

Medicine was at last effectually divorced from theology by a special bull procured from the Pope, which permitted physicians to marry. During all the ages that the healing art was held and practised by the priest-physicians, its degradation was extreme and disgraceful to the last degree. The most absurd reports were made of miraculous cures, attested by monks, abbots, bishops, popes, and consecrated saints. They alleged that they had restored the blind, the epileptic, the insane, etc. "The saints of the Romanists have usurped the place of the zodiacal constellations in their governance of the parts of man's body; for every limbe they have a saint. Thus St. Otilia keepes the head instead of Aries; St. Blasius is appointed to governe the necke instead of Taurus;" and so old Melton goes on to the end of the list. Pettigrew[2] gives the names of nearly fifty Roman Catholic saints who were believed to have special control over certain individual diseases, both medical and surgical. The priesthood also assigned saints to wells and springs, to give healing virtues to their waters; instituted health-seeking pilgrimages to these places; introduced charms, relics, and amulets into use, as preventives and cures of disease, and altogether prostituted the healing art to priestcraft and quackery.

As early as the times of Charlemagne, each of the cathedrals maintained a school, in which writing, arithmetic, singing, theology, and, in some instances also, medicine and surgery, were taught. The Episcopal College of Paris had medical professors who gave advice and treated surgical cases, either at the portals of Nôtre Dame, or in the interior of the church.[3] This was also done in other cities. After the emancipation of the healing art from the hands of the clergy, by the Popes and Councils as above stated, the Episcopal schools were erected into universities, in which the several departments of learning were taught in separate colleges by distinct faculties, whose professors devoted themselves to their special branches. In the year 1271, the foundation of the College of Surgeons, at Paris, was laid by Pitard, who was a surgeon of eminence. In fact, most of the great universities of Europe were created in the thirteenth century. Of these, may be mentioned, those of Bologna, Padua, Naples, Paris, Montpelier, Toulouse, Valentia, Tortosa, and Oxford. The earliest medical and surgical teaching of all these schools was essentially Arabic, or, at least, what may be not inaptly termed, second-hand Greek medicine and surgery. This was rendered available through the indefatigable labors of Gérard de Cremona, of Lombardy. He acquired the Arabic language, betook himself to Toledo, rich in Arabic literature, and "armed with this powerful resource, which none of the Occidentals since Constantine the African had possessed, he could not see before him so many Arabic works on all the sciences, without feeling an intense desire to transmit them to the Latins, *as to a cherished heiress*, says his naïf biographer, and the rest of his life was occupied in making translations. Amid the mass of his translations are found those of some of the treatises of Hippocrates and Galen; the work of Serapion, the books of Rhazes to Almansor, the immense canon of Avicenna, and, what interests us still more, the treatise on surgery by Albucasis. He died in Cremona, in 1187, at the age of seventy-three, and left all his books to the convent of Sainte Lucie, in which he was buried."[1]

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[1] Pettigrew, On Superstitions connected with the History and Practice of Medicine and Surgery.

[2] Op. cit.

[3] Renouard, History of Medicine, Am. ed., 1856.

About the beginning of the thirteenth century, certain independent thinkers began to appear, and by their teaching, example, and works, gave a new impulse to the science and art of surgery. Instead of following blindly in the track of ancient authority, they began to use their own eyes, to act upon the dictates of reason, and to be governed by the suggestions of clinical experience. Of these new lights none shone more conspicuously than Gulielmus de Saliceto, a professor, first at Bologna and subsequently at Verona, who is said to have been "a powerful man" in medicine and surgery. His work on surgery is still extant, and it affords ample proof that he was governed more by his personal experience than by the opinions of his masters. William of Salicet died about 1280.

Lanfranc, of Milan, was a pupil of the last-mentioned writer. He practised surgery in his native city until he was exiled on account of the dissensions of the Guelphs and Ghibelines, when he betook himself to France, first sojourning at Lyons, where he wrote his "Chirurgia Parva," and after a few years taking up his residence in Paris, to which city he had been induced to go by the dean of the Faculty of Medicine. In 1295 he opened a course on surgery which proved eminently successful. In 1296 he published his "Chirurgia Magna." Death closed his career about the year 1306.

Brunus, of Calabria, another surgical writer of that period, practised at Padua, in the middle of the thirteenth century.

Guy de Chauliac was the most famous of all the surgeons in what has been called the Arabic Period. He was more learned than any surgeon of his time, or any of his immediate predecessors. He was a man of sterling character, pure in morals, fearless in the discharge of duty, eminent in the estimation of men in exalted positions. He was the physician of three successive popes, between the years 1340 and 1370—viz., Clement VI., Innocent VI., and Urban V. As Mundinus was the restorer of anatomy in the fourteenth century, so Guido was that of surgery at the same period. Previous to his time, for the most part, it was a miserable art, practised chiefly by men of gross ignorance, being the acknowledged property of barbers and itinerant quacks. Guy was the first to reduce the art of surgery to a system, and to manifest a spirit of independent criticism. He composed his

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[1] Malgaigne, Œuvres d'A. Paré, Introd., p. xxvii.

"Grande Chirurgie," which he styled *Inventarium, sive Collectorium Artis Chirurgicalis Medicinæ*, in the year 1365. He was then ripe in years, possessed of immense erudition, of ample experience, of mature judgment, of nobility of mind, and of singular purity of principles.[1] Guido revived the use of the trephine. He is the earliest surgical writer who mentions the Cæsarean operation, which, however, he advises to be resorted to only after the death of the mother, solely to save the life of the infant. Portal[2] sums up his account of this old master in the following words: "Finally, it may be averred that Guy de Chauliac had said nearly everything which modern surgeons say, and that his work is of infinite value, but, unfortunately, too little read, too little pondered. He described many instruments, among others a forceps for the ligation of arteries." Renouard[3] says, "The work of Guy de Chauliac became very soon the surgical code of Europe; translated and commented upon in all tongues, and reproduced under different forms, it was for a long time classic, and still preserves its interest, as representing the state of science at the close of the middle ages. He has written, moreover, in a clear, concise, and even picturesque style, very superior to the barbarous Latin of most of the writers of his time."

Space will not admit the mention of all the surgical writers of this interesting period. Roger, Rolland, Brunus, Theodoric, and others, have left more or less complete treatises on surgery which are still extant. They contain nothing more, but rather less, than is to be found in the works already referred to.

The revival of anatomical study, directly from the cadaver, in the early part of the fourteenth century, by the lectures, demonstrations, and writings of Mundinus of Bologna, was an event of momentous importance in its relations to the improvement and progress of surgery. Anatomy is to surgery what sailing charts are to navigation. Surgery was not as much indebted, however, to the teaching of Mondino himself, as to that of those who followed in his wake, Alexander Achillini, Nicholas Massa, Carpus, Dryander, and in later times, the more brilliant train, among whom were Sylvius, Winters, Vesalius, Columbus, Fabricius ab Acquapendente, Harvey, and many others.

Surgery previous to the beginning and middle of the fourteenth century must have been well nigh extinct in England. The first writers on this subject, of whom we have any knowledge, were Gilbertus Anglicus, John of Gaddesden, and John Ardern. The two former did not attempt to write complete treatises upon surgery, but mixed what they had to say on the subject with all sorts of things relating to the healing art. One looks in vain through the *Compendium totius Medicinæ* of Gilbertus, or the *Rosa Anglica* of Joannes, to find much that would enlighten a student of surgery even in that shadowy age. What they contain is little more than a confused mass of extracts from Arabic surgical writers, together with recipes of questionable value, odd formulæ, and an endless array of apocryphal and superstitious remedies, among which amulets and charms occupy a conspicuous position. Guy de Chauliac, a contemporary of whom I have already spoken, and one of incomparable worth, thus speaks of the famous "Rosa Anglica" of Gaddesden. "Finally appeared a pale English rose, which was sent to me, and I perused it. I did hope to find in it sweetness of perfume, but I only found the fables of the Spaniard Gilbert and of Theodorus."

"Maister Arderne" seems to have been the first surgical writer of England who is worthy of special mention. He was sergeant-surgeon of Edward III., in 1346, and a man of large experience, who wrote a work on surgery which was characterized by simplicity, frankness, and honesty. He well deserves to be styled the Father of English Surgery. Several manuscripts of his work are preserved in the libraries of Great Britain. One has recently been described in The Dublin Journal of Medical Science. This MS. is entitled "The Workes of Maister John Arderne, Chirurgeon of Newarke, in Nottinghamshire, written by his own hand, in the year of our Lord 1349." He also wrote a special work on "Fistulæ in the fundament, etc.," which disease he treated with remarkable skill. This work was translated by John Read, and published in English, at London, in 1588. It is a small quarto of twenty-eight leaves or fifty-six pages. It commences thus: "Heere beginneth a treatise of the Fistula, in the fundament, or other places of the body, and of Imposthumes causing Fistulaes, and of the office pertaining to the Chirurgion: with certain other things. By M. Iohn Arden. Prologus. Anno Domine 1349."

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[1] See my sketch of Guy de Chauliac, in Annals of Anat. and Surg., vol. ii., 1880, p. 419 *et seq.*

[2] Hist. de l'Anat. et de la Chirurg., tome v.

[3] Op. cit., p. 284.

Then follow brief allusions to his personal history, by which we learn that he "Iohn Arden from the first pestilence in the yeere of our Lord God 1349. Dwelled in New-warke, in Nottingham shire, unto the yeere of our Lord 1370. And there healed many of the Fistulæ in the fundament," also "Afterward in Anno 1370, I came to London." He relates many cases, and describes the instruments employed, all of which is done in a spirit of honesty and humility. He remarks, in his "Prologus," "Therefore to the honour of almightie God, that opened knowledge to mee, that I should finde treasure within the fielde of knowledge, that with longe time and panting breast, I have sweat and travailed, and full busilie indevored my selfe as my facultie suffiseth, to sette foorth this worke faithfullie, for the utillitie and profit of those that come after."

His treatment of fistula in ano was either by incision or by ligature. John was very careful to make a good bargain. "You ought to foreshew unto the patient the hardnesse of the cure, which, if he bee conformable unto, you may proceede in gods name unto your cure, with this caveat, to take for your cure as much as you can with good assurance for your mony when you have done." Yet, withal, he lays down a high-toned ethical code for the guidance of the faculty. He gives "a description of ye qualities and conditions which ought to be in ye surgeon that performeth this or any other operation in chirurgery: First, that he be devout. Secondlie, charitable to ye poor. Thirdly, to use few words. Fourthly, to avoid drunkenness. Fifthly, to be chaste both in words and gesture, as well as to fear ye not. Sixthly, not to undertake an incurable disease."

Two events occurred in the fifteenth century which gave a great impetus to the advancement and diffusion of medical and surgical knowledge throughout Europe. The first was the capture of Constantinople by the Turks, which occasioned a multitude of Christians to flee from that city into Italy. These refugees brought with them many rare and precious manuscripts of Greek medical writers, hitherto unknown, some of which were subsequently translated into Latin, while others in the original were soon to be broadly disseminated through the agency of the second great event, the invention of printing. This invention cannot be sufficiently appreciated. It constitutes an epoch in the world's history.

The close of the fifteenth century added another event to surgical history of incalculable importance. The discovery of America led to an intercontinental exchange of two of the most loathsome diseases which afflict the human family—pox and smallpox. Europe gave America smallpox, and received in return syphilis. The former disease has already been mitigated and its extinction rendered possible by the immortal Jenner; so let us watch and pray that another Jenner may arise to perform a like miracle with the latter curse, which, though less fatal in its immediate effects, is none the less deadly in its insidious after-results. From the year 1492 a new literature sprang up, thenceforth to grow far more voluminous than satisfactory. The bibliography of syphilis tells a tale of endless jangling, of irreconcilable differences of opinion as to the nature and treatment of the malady, of countless essays and treatises, of interminable dissertations and disputations, from the mildness of honey-dew to the sharpness of the electro-galvanic cautery.

Down to the middle of the fifteenth century, the operation of lithotomy was exclusively practised by itinerant specialists. They scarcely deserve the name of surgeons. They were evidently ignorant, conceited, and mercenary quacks. They entered the towns where they sought patients with loud and pompous heralding, and performed their operations in the open air with the utmost degree of display. From the ancient days of Hippocrates, who totally ignored the operation, and made his pupils swear by Apollo and all the gods that they would not undertake it, lithotomy had been performed by travelling stone-cutters, as they were called. The Celsian method has already been referred to. The operation is only spoken of in this place to point out the time of its reclamation to legitimate surgery. This was effected by Germain Colot, who was a French surgeon of great renown, and in high favor with Louis XI. About the year 1460, having gained the confidence of some of these wandering Italian lithotomists, he was allowed to be present, and even permitted to assist in several of their operations. Colot having attentively observed all the details of their procedures, declared that it was a shame and a disgrace that an operation of so much importance should have been so long and so entirely neglected by the surgeons of his own country. He accordingly resolved to remove the opprobrium by instituting a series of experiments upon the cadaver, which having done, he promptly communicated the results to the medical faculty of Paris and the physicians of the court, from all of whom he received hearty encouragement. Having thus carefully prepared himself, he obtained permission of the king to operate on a culprit who had been condemned to death, and who was known to have suffered severely from stone in the bladder. The death sentence having been commuted to lithotomy, Colot performed the operation successfully in the churchyard of St. Severins, in the presence of the king, cured his patient, received a liberal pension, advanced the art of surgery, and rendered his own name immortal. Space will not admit of a complete history of this operation.[1] Colot's method of performing it was kept secret for a long period, and was greatly improved by Joannes de Romanis, of Cremona, and by Mariano Santo de Barolotta, of Naples, by the invention of the grooved staff upon which the median incision was made, all of which was finally published in 1534. The names of Pierre Franco, François Rousset, James and John Douglas, William Cheselden, J. J. Rau, and Frère Jacques, are all associated with the history of lithotomy—a history extremely curious and full of interest.

The sixteenth century was a brilliant period in the history of anatomy and surgery. It was the period of reformation in all that related to the healing art. The keen-eyed observer was richly rewarded for all his well-directed researches, both by the correction of numberless errors which had been perpetuated for centuries, and also by new and important discoveries. Among the most eminent and celebrated anatomists who flourished about the middle of this century was Andreas Vesalius, who was born at Brussels, December 31, 1514. At the age of twenty-eight, he sent forth from the press a far more extensive, accurate, and splendid work on anatomy and physiology than the world up to that time had ever seen. It is a sumptuous folio of nearly seven hundred pages, profusely and beautifully illustrated with very excellent figures drawn from reality. It was not only then, but it is now, though three and a half centuries have passed away since it appeared, a glorious book; a monument of genius, industry, and liberality. This work was followed by the anatomical and surgical treatises of Columbus, Fallopius, Fabricius ab Acquapendente, and others, all of which increased the accuracy of surgical science and the artistic skill of surgeons.

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[1] I have given a more extended account of it in the second volume of the Annals of Anatomy and Surgery, 1880, under the title of "Germain Colot and the old lithotomists."

Surgery owes much to the genius and practical experience of that sterling old hero and grand master in chirurgerie, Ambroise Paré. He was born at Laval, in the province of Mayenne, in France, about the year of Grace 1509. He lived one and eighty years, and died in Paris, December 20, 1590. His parents were poor, his early education defective, his ambition and aim lofty, and his will and courage indomitable. A kindly priest undertook the culture of young Paré's mind, while in return he undertook the culture of the priest's garden, and the grooming of his mule. In time Paré was duly apprenticed to a barber-surgeon, whose name was Vialot, from whom he acquired the rudiments of minor surgery. The great lithotomist Germain Colot chanced to come in the neighborhood where Paré was a student, and asked the young surgeon to hold the legs of a patient on whom he proposed to operate for stone in the bladder. Paré was charmed with the skill and dexterity of Colot, and resolved to betake himself to Paris the better to perfect himself in the art of surgery. He served three full years as house surgeon in the Hôtel-Dieu, a hospital which was then and still continues to be famous among similar institutions. At the age of twenty-seven he was appointed a military surgeon, in which capacity he served his country with much distinction, at a time when wars were rife, for no less than a third of a century. He was not only a member of the fraternity of Barber-surgeons, but in time became exalted to a position of official eminence in this important guild. "The kings of France transmitted him to their successors as a legacy of the crown." Henry II., Francis II., Charles IX., and Henry III., each chose Paré as his physician and surgeon-in-chief, and also as member of the privy counsel. Paré was an earnest, simple, and frank Huguenot. But for his remarkable skill, and the value of his services to the crown and the state, he too would have fallen a victim to the atrocious fanaticism which culminated in the horrible massacre of St. Bartholomew's Day.

His personal history has the charm of a romance, and his works are almost as fascinating as a fairy tale. The reader should do himself the pleasure of making the acquaintance of both author and book. Paré introduced many novelties and improvements into practical surgery. The application of the ligature to cut or wounded bloodvessels was revived, if indeed it had ever been previously practised in Europe. He believed this method of arresting traumatic hemorrhage to be new, and to have come to him by inspiration. He says "I think it was taught me by the special favor of the sacred Deitie; for I learnt it not of my masters, nor of any other, neither have I at any time found it used by any." It is possible that some of this inspiration came from the ancients, since he adds, "Only I have read it in Galen, that there was no speedier remedy for staunching of blood than to bind the vessels through which it flowed towards their roots, to wit, the liver and the heart." Celsus, Avicenna, Albucasis, and other ancient and mediæval surgical writers, had spoken of the ligation of bloodvessels; yet for ages previous to the time of Paré the actual cautery had been the principal means of staunching blood in wounds and surgical operations. Certain it is that the ligature was not in use in his day, and that its employment by Paré brought upon him violent and unmerited abuse. Thus, we find Gourmelen calling him a blood-thirsty and cruel rascal.

We can fix almost the exact date at which the ligature was first employed by Paré, since the edition of his work published in 1552 mentions only the cautery as a means of arresting hemorrhage, while the edition of 1564 contains his first mention of the ligature for this purpose. After he had adopted this method he seems to have looked back upon the use of the hot irons with terror, "a thing very horrible and too cruel to be mentioned." He laments that he should ever have used it, "whereof I am ashamed and aggrieved." "In conclusion, I counsel the young surgeon to abandon this miserable way of burning and roasting." The introduction of the ligature for arresting traumatic hemorrhage is of so much importance that it marks an epoch in the history of surgery. When, a little farther on, I shall take occasion to speak of William Clowes, one of the chirurgeons of Queen Elizabeth, and of his "Profitable and Necessarie Booke," it will be seen by contrast how important the ligation of arteries is in amputations and other surgical operations. The collected works of Paré make a ponderous folio of more than a thousand pages, the result of fifty years' labor. He says, "I aimed that antiquity may seeme to have nothing wherein it may exceed us, besides the glory of invention; nor posterity anything left but a certaine small hope to adde some things, as it is easie to add to former inventions." He thus speaks of its pictorial illustrations: "Being a lover of carved workes, I beautified it with three hundred formes, or graven figures and apt delineations, in which whosoever shall attentively looke shall find five hundred anatomicall or organicall figures belonging to the arte (if they be reckoned particularly). To every one of these I have given their names and showed their use, least they should seeme to have beene put in vainly for ostentation or delight."[1]

Paré was the first to repair laceration of the perineum by sutures, and also the first to extract loose cartilages from the knee-joint. In his works will be seen drainage-tubes; the club-foot boot; a saw in every particular like that called Hey's; also fine models of artificial legs, hands, noses, ears, and eyes. While it is true that Paré greatly simplified the treatment of wounds, particularly gunshot wounds, by putting an end to the barbarous practice of scalding them by pouring into them boiling-hot oil, yet he was far from being free from credulity and absurdity. He tells us in his "Voyage of Thurin, 1536," the occasion that brought about this change, and also how he obtained a "receipt of an excellent balme for wounds with gunshot." He had read in "John de Vigo's book of wounds in generall," that wounds made with powder and ball must be cauterized with "oyle of elders scalding hot." So finding that all the other chirurgeons followed this practice, he says:—

> I tooke courage to doe as they did. At last I wanted oyle, and was constrained in steed thereof, to apply a digestive of yolkes of egges, oyle of roses, and turpentine. In the night I could not sleepe in quiet, fearing some default in not cauterizing, that I should finde those to whom I had not used the burning oyle dead impoysoned; which made me rise very early to visit them, where beyond my expectation I found those to whom I had applyed my digestive medicine, to feele little paine, and their wounds without inflammation or tumor, having rested reasonable well in the night: the other to whom was used the sayd burning oyle, I found them feverish, with great paine and tumour about the edges of their wounds. And then I resolved with my selfe never so cruelly to burne poore men wounded with gunshot. Being at *Thurin* I found a chirurgion, who had the fame above all others, for the curing of wounds of gunshot, into whose favour I found meanes to insinuate my selfe, to have the receipt of his balme, as he called it wherewith he dressed wounds of that kind, and hee held me off the space of

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[1] Works. (Johnson's Translation.) London, 1634.

two yeeres, before I could possible draw the receipt from him. In the end by gifts and presents he gave it me, which was this, to boyle young whelpes new pupped, in oyle of lillies, prepared with earth wormes, with turpentine of *Venice.* Then was I joyfull and my heart made glad, that I had understood his remedy, which was like to that which I had obtained by great chance. See then how I learned to dresse wounds made with gunshot, not by bookes.[1]

Paré gives us a little example of his egotism at the close of this chapter, when he says: "and if there were four hurt, I had alwayes three of them, and if there were question of cutting off an arme or a legge, or to trepan, or to reduce a fracture or dislocation, I brought it well to passe," . . . "and when wee had resolved to doe any serious worke of chirurgery, twas *Ambrose Parey* that put his hand thereto, where I did it promptly and with dexterity, and with a great assurance, in so much that the sayd physition admired me, to see me so ready in the operation of chirurgery, seeing the small age which I had." He was then about twenty-seven years old.

We can pardon all this vanity and egotism in a man who, three and a half centuries ago, taught surgeons to use ligatures in place of red-hot irons for the arrest of hemorrhage from divided bloodvessels; who revolutionized the treatment of gunshot wounds by proving that they were not poisoned wounds, and that simple dressings, yea, even the balm of puppies, was much to be preferred to cauterization with boiling hot oil; that lacerations of the perineum could be readily cured; and that pus could be drawn from deep-seated wounds and abscesses by means of drainage-tubes; and who also taught the profession many other practical lessons, and devised many other useful improvements, in operative surgery.

Thomas Gale, maister in chirurgerie, was a military surgeon of England, whose writings exercised a powerful influence in their day in the correction of errors concerning the poisonous character of wounds inflicted by gunpowder and by bullets. The gunpowder was, previous to his writings, supposed to be venomous, while the ball was believed to accumulate heat in its flight, and thus presumed to act upon the tissues through which it penetrated as an actual cautery. Such had been the teachings of the most eminent writers on the subject down to the middle of the sixteenth century. Gale successfully confuted these errors of Jerome of Brunswick, Giovanni di Vigo, Alfonso Ferri, and others. Thomas Gale was born in 1507, was a contemporary of Paré, and received his professional education from Richard Ferris, sergeant-surgeon to Queen Elizabeth. Gale served in the army of Henry VIII. at Montrieul, in 1544, and also with King Philip at the battle of St. Quintin, in 1557, and afterwards settled in London, where he practised surgery with distinction. He published four small works on surgery in the year 1563. "An institution of a chirurgion, containing the sure grounds and principles of chirurgerie." "An enchiridion of chirurgerie, conteining the exact and perfect cure of wounds, fractures, and dislocations." "An excellent treatise of wounds made with gunshot, in which is confuted both the grose errour of Ierome Brunswicke, John Vigo, Alfonce Ferrius, and others, in that they make the wound venimous which commeth through the common pouder and shot. And also there is set out a perfect and true methode of curing these woundes." "An antidotarie conteining hid and secret medicines, simple and compound, as also all such as are required in chirurgerie."

Besides the above, he published in 1579 a translation of "Guido's questionaries of chirurgerie," and an epitome of the third and fourth books of Galen; and in 1586 he published several treatises under the following general title-page: "Certaine workes of Galens, called methodus medendi, with a briefe declaration of the worthie art of medicine, the office of a chirurgion, and an epitome of the third booke of Galen of natural faculties: all translated into English."

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[1] Ibid., p. 1144.

Gale gives a graphic account of the degraded state of military surgery in his time:—

> I remember when I was at the wars of Muttrel, in the time of that famous prince, King Henry the Eighth, there was a great rabblement there that took upon them to be surgeons. Some were sow-gelders, and horse-gelders, with tinkers and cobblers. This noble sect did such great cures that they got themselves a perpetual name, for like as Thessalus's sect were called Thessalians, so was this rabblement, for their notorious cures, called dog leeches; for in two dressings they did commonly make their cures whole and sound for ever, after. But when the Duke of Norfolk, who was then the general, understood how the people did die, and that of small wounds, he sent for me and certain other surgeons, commanding us to make search how these men came to their death, whether it were by the grievousness of their wounds, or by the lack of knowledge of the surgeons; and we, according to our commandment, made search through all the camp, and found many of the same good fellows which took upon them the name of surgeons —not only the names, but the wages also. (Having ascertained that they were imposters, he adds): but in the end this worthy rabblement was committed to the Marshalsea, and threatened by the Duke's grace to be hanged for their worthy deeds, except they would declare the truth what they were, and of what occupation; and in the end they did confess as I have declared to you before.

The influence of Gale's writings and example was greatly to simplify the treatment of wounds of all kinds, to elevate the standard of professional education, and to improve the character of practitioners.

There are two curious little treatises, still extant, written in English by William Clowes, who was born about the year 1544. He was a naval surgeon, and served on one of the queen's ships, the Aid, about the year 1570. In 1573 he was engaged in full practice in London. He was "one of her Maiesties Chirurgions," and for several years a surgeon in the "Hospitall of Saint Bartholomewes," and also in "Christs Hospital." The first of these tractates bears the following quaint title: "A briefe and necessary treatise, tovching the cvre of the disease, now vsvally called Lves Veneria, by vnctions and other approved wayes of cvring." The first edition was printed at London, in 1585, the second in 1596, and the third and last in 1637. It is surprising to learn from this work how great a number of cases of syphilis occurred at that time in the city of London, then comparatively a small town. He says:—

> If I be not deceived in mine opinion (friendly reader) I suppose the disease it selfe was never more rife in Naples, Italie, France, or Spaine, than it is at this day in the realme of England. I pray God deliver us from it, and to remove from us that filthy sinne that breedeth it. It is wonderfull to consider the huge multitude of such as be infected, and that daily increase, to the great danger of many. The causes whereof, I see none so great as the licentious and beastlie disorder of a great number of rogues and vagabonds, the filthy life of many lewde and idle persons, men and women, about the citie of London, &c. By means of which disordered persons, some other of better disposition are many times infected, and many more like to be, except there be found some redresse for the same: I may speake boldly, because I speake truly: and yet I do speak it with griefe of minde, that in the Hospitall of Saint Bartholomew in London, there hath been cured of this disease by me and three others, within five years, to the number of one thousand and more. I speake nothing of Saint Thomas Hospitall, and other houses about the citie, wherein an infinite multitude are daily cured. The masters of the foresaid hospitals, being moved with devotion, and a Christian-like care towards these wicked and sinfull creatures, are daily inforced to take a number of these

diseased people, that otherwise would infect many good and honest persons, seeking with like care to restraine this grievous infection, and yet the number still increaseth.

His treatment consisted chiefly of mercurial inunction, carried to the extent of salivation. He also used turpeth mineral, fumigations, caustics, etc. These were the approved remedies of that day, and they have been continued through the past three centuries, almost without change, to the present time. The literature of syphilis, embracing four hundred years, is overwhelmingly voluminous. The progress made in the prevention and cure of the disease has been lamentably small and insignificant.

The other treatise of Master Clowes, to which I have referred, and far the more important of the two, was first printed, in small quarto, at London, in 1591, and reprinted in 1596, and in 1637; the two later editions being "newly corrected and augmented," with alterations of title-pages, etc. The first edition bears the following title: "A proved Practice for all young Chirurgians, concerning Burnings with Gun-powder, and Woundes made with Gun-shot, Sword, Halbard, Pike, Launce, or such other." The third edition, 1637, which is the only one I possess, has a still more quaint title. "A profitable and necessarie booke of observations, for all those that are burned with the flame of Gun-powder, &c., and also for curing of wounds made with Musket and Caliver shot, and other weapons of warre, commonly used at this day both by Sea and Land, as hereafter shall be declared:" etc. This "booke" contains the histories of many very interesting cases, and affords an admirable view of English surgery in the Elizabethan period. It is well worthy of careful perusal. The only use I can make of it in this place, is to quote Clowes's description of the mode of performing amputations, the arrest of hemorrhage, and the method of dressing the stump:—

The manner and order of taking off a mortified and corrupt leg or arme, which commeth oftentimes, by reason of wounds made with gunshot, &c. (Cap. 24.)

Sith as I have said, that oftentimes it happenth, by reason of the evill accidents which follow wounds made with gunshot, &c. That the whole member commeth to gangrena, sideratio, or sphacelus, so that we are many times constrained forthwith to make a speedy dispatch, to cut off the member, which shall be done as Gale and others very skilfully have pointed in the whole and sound parts. And if it so fall out that the leg is to be cut off beneath the knee, then let it be distant from the joint fower inches, and three inches above the knee; and so likewise in the arme, as occasion is offered. These things being observed, then through the assistance of Almightie God, you shall luckily accomplish this worke by your good industrie and diligence. But you must be very circumspect and careful of all things, which concerne the methodicall perfection of this worke; that is, you shall have a great regard to the state of his body for evacuation and dieting: And after that his body is well prepared and purged, then the same morning you do attempt to cut off the member, be it leg or arme, let him have some two houres before, some good comfortable caudell, or other broths, according to the discretion of the Physition or Chirurgion, only to corroberate and strengthen his stomache, and in any wise omit not, but that he, or shee, have ministered unto them some good exhortation concerning patience in adversitie, to be made by the minister or preacher. And you shall likewise advertise the friends of the patient, that the worke which you go about is great, and not without danger of death, for that many accidents and evill symptoms do happen, which in such cases many times do admit no cure; all which being well considered, then ordaine the night before, some good defensative, and let it be applied two or three times about the member.

All which being considered, you shall have in readiness a good strong and steady fourme, and set the patient at the very end of it; then shall there bestride the fourme behind, a man that is able to holde him, or hir fast, by both the armes; which done, if the leg must be taken off beneath the knee, let there be also appointed another strong man to bestride the leg, that is to be cut off, and he must hold the member very fast above the place where the incision is to be made, and very steadily, without shaking, drawing up the skin and muscles, and he that doth so hold, should have a large strong hand, and a good fast gripe, whereby he may the better stay the bleeding, in the place and steede of a straight band or ligature, which hand indeed is also very necessarie, for by reason of the hard and close binding, it doth so benum that part, that the paine of the binding doth greatly obscure the sence and feeling of the incision; and the foresaid hand is also a good direction for him that doth cut off the member; but yet in some bodies, it will not be amisse to admit bleeding according to discretion, specially in such bodies as are of hot complexions, and do abound in blood, and I have often seene, by the skillfulnes of the holder, there hath not been lost at a time fower ounces of blood; for in weake bodies it is not good to loose much blood: for blood is said to be the treasure of life, and for that cause chiefly, a good holder is not to be spared. In like manner, there must be chosen another skilful man, that hath good experience in holding the leg below, for the member must not be held too high, for feare of staying or choking of the same, neither must he beare down his hand too low, for feare of breaking or fracturing of the bones in the time it is a sawing or cutting off. And he that is the master or surgeon, which doth cut off the member, must be sure he have a sharpe sawe, also a very good catlin, and an incision knife, and then boldly, with a steddy and quicke hand, cut the flesh round about to the bones, without staying, being sure the periosteum, or panicle that covereth and compasseth the bones be also incised and cut, and likewise a certain muscle or sinew, that runneth betweene the bones of the leg which shall be done with your incision knife: All this being orderly performed, then set your sawe as neere unto the sound flesh, as well you may, and so cut asunder the bones, which done, *Ambrose Pare*, a man of great knowledge, and experience in Chirurgie, willeth, presently after the bones are cut asunder, that yee then draw the sides of the wound together, with fower stitches, that are deepe in the flesh, and made crosswise over the member, like unto the letter X, for saith he, you may easily draw the portions of the skin and their divided muscles, which before the section were drawne upward, over the bones, and cover them close on every side, that they may take the less aire, and the wound sooner conglutinate, &c. I must confesse that I have cured many, and yet never so stitched them: notwithstanding, I wish all men to follow in the best way, for the good of their patient.

But I say, having prepared in a readiness, this restrictive, to staie the flux of blood, I proceeded then as followeth: ℞ *Boli Armeniaci* ℥iij, *Sanguinis Draconis*, *Aloes*, *ana* ℥j, *Olibani* ℥jss, *Terræ sigillatæ*, *Mastichis ana* ℥j, *Lapidis Hæmatitis* ℥ss, *Calcis ex Testis ovorum*, *Mummiæ*, *ana* ℥j, *Gypsi* ʒij, *Farinæ Volatilis* ℥iv. *Misce.* Take of this Powder as much as will serve your turne, and mixe with the said Powder, *Pilorum leporis, et ovorum albuminum ana quod satis est*, let your Hare haires be the whitest and the softest that is taken from under the belly of the Hare, and cut so fine as possible may be, and with the said powder let all be mixed togither, and so brought to a reasonable thicknesse. And note that before yee cut off the member, let there be in like manner made for the purpose, three or fower small bolsters or buttons, fashioned in the top or upper part like a Dove's egge, or as a sugar lofe button, flat in the bottom to the compasse of a French crown, and round upwards as aforesaid; and these you shall make of very fine towe, according to Art, wrought up in water and vinegar, whereupon you shall apply some part of the restrictive, being mixed as I have before declared. But yee shall heere further note that one *Gulemew*, a famous Chirurgeon in France, with other very learned and skilful men, counselleth us to drawe out the veins and arteries with an instrument called a Raven's bill, and then they tie those vessels with a double strong ligature or thread, and so safely stay the bleeding, but for that I never practiced this order by stiching the veins and arteries, I will leave it as aforesaid, and procede with mine owne approved practise: and, therefore, I say when the holder of the member above the knee doth partly release the fast holding of his hand, by little and little, whereby you may the better perceive and see the mouths of the veins, that are incised and cut, and upon those veins you shall place the round endes of the small buttons, and upon them presently lay on a round thicke bed of towe made up in water and vinegar, so that it be fit as neere as you can guess it, to the compasse of the stumpe or member that is taken off, and thereon spread the restrictive; and upon that againe, you shall lay another broder bed of towe made up as you have heard, so large that it may compasse over the member, and that it may be safely tied to keepe on the rest; whereupon yee shall in like manner spread of the restrictive reasonable thick, afore yee place it to the rest, and yee shall cut it in fower places, one cut right over against another, an inch in length and somewhat more: and yee shall tie or fasten the said large bed to with a ligature, which they call a choke band doubled two or three times, being flat, and fully an inch brode and a yard long: in the middle of the said ligature or band, you shall spread some of the restrictive, so that it may take the better hold unto the large bed of towe, being very fast tied, then you shall place thereon a double large bed of soft linnen cloth, and then with a strong rowler of fower inches brode, and three or fower yards long, let it be artificially rowled, and where the blood beginneth to shew, in that place speedily lay on a good compressor or thicke bolster made of tow brought up in water and vinegar, the thickness in the middle to a man's hand, and the thinner towards the edges, in compasse of a Philip's dolor, more or lesse, as you suppose the greatness of the flux to be, and couch them close to, in as many places as the blood doth shew itselfe, and thus with two or three rowlers, and as many soft linnen beds, some single, and some double, with a sufficient number of bolsters, some great and some small, you may safely stay the flux of blood: which order and way did never faile me, nor any other that have used the same according unto the order here prescribed: also sometimes we do use to draw over the great bed of tow, being surely tied with the foresaid chokeband, a wet Oxe bladder, and so do pull it close up over the same, the which is tied fast also with a ligature or chokeband, and upon the same a double or single bed of soft linnen cloth, and thus with a few brode bolsters and rowlers very orderly is staied the flux of blood. All which being artificially done, then you shall as easily as possible may be, carie the patient to his bed, having a pillow made ready to rest the member on: Thus let him lie with as much quietness as you can, keeping a convenient diet; then the third or fourth day if nothing do let, you shall have in a readiness steuphs of white wine, with decent rowlers and bolsters, and other necessaries meete for the second dressing. To conclude, yee shall here observe, that if at any time you have not of my restrictive powder in a readiness, you may use either *Vigoe's* order, to cauterize the place, with a bright cauterizing iron, or else with *M. Gale's* powder, which is a most worthy invention, and better pleaseth the patient, than the hot glowing irons, which are very offensive unto the eie. But yet the powder wrought with extreme paine, and made a very great eschar, and by that means the bone hath been afterwards new cut againe, and so did make a very long work in some, ere ever they were cured. The powder which I have here published, is of my own invention, and it never causeth paine, but often bringeth with it a perfect white digestive matter, which powder I did keepe secret to mine own private use, and I did first put it in practice in the Hospital Saint Bartholomews, as it is well knowne at this day unto some of the Surgeons that then served with me there, who were present with me at that time, when there was taken off in one morning, seaven legs and armes, where, by the assistance and helpe of Almightie God, we staied all their fluxes of blood, without any paine unto them, but onely in the compression and close rowling, and tenderness of the wound excepted. After that time, it was given out, and made knowne to divers Surgeons, that were very desirous to have it.

The "gentle reader" will excuse me for having made so lengthy a quotation from the "booke" of Master Clowes. It is historically extremely interesting, as it was written at the period of transition from the barbarous use of the actual cautery as a means of arresting traumatic hemorrhage, to the employment of the ligature for this purpose. Here we learn the composition and use of "restrictive powders," of the custom of keeping their methods and inventions profoundly secret, of the complex dressings of stumps, of the caution and tardiness with which new modes of practice were adopted, as shown by Clowes's rejection of the ligature, and of the covering of the stump with the integument, which was the forerunner of the flap operation. We also learn from this work of three centuries ago, how remarkably well the old English surgeons succeeded in "staing all the fluxes of blood" in their cases of amputation, and also observe with admiration how antiseptic, air-excluding, almost Listerian, these somewhat clumsy dressings were.

Surgery was enriched by many improvements in the course of the eventful sixteenth century. The surgery of war received particular attention, but it would be entirely impracticable to attempt an enumeration of all that was done in the field of military surgery. Neither will space admit of a list of the names of the authors, or of the treatises, both great and small, which were added to the literature of the subject during this period. A brief allusion to a few of the most celebrated is all that can be made in this place.

Alfonso Ferri, Ferrus, or Ferrius, as we often find it spelt, was a native of Naples, and flourished about the middle of the sixteenth century. He arose to great eminence, being the first physician and surgeon of Pope Paul III., and was the author of several works on surgery as well as on venereal diseases. He was the inventor of a very ingenious instrument for the extraction of deeply imbedded bullets, which device was employed by surgeons for many years, being always known as the *Alfonsinum.* It consisted of three spring steel branches, equal in size, and with sharp retractile teeth ; these were fixed in a handle, and held together by means of a sliding ring, and when closed the end was round and smooth, as was also the cylinder which was made by the junction of the three branches. In this condition it was passed along the sinus made by the ball, which, when touched, was grasped, by sliding up the ring and permitting the branches to expand. Having thus been seized, the ring was pushed down tightly, and the instrument holding the bullet extracted. The *Alfonsinum* became the model for many similar prehensile instruments, some of which are still employed in surgery.

In the year 1555, there was published in Latin, at Tigurium (Zurich), a magnificent folio of more than four hundred leaves, under the title "*De chirurgia scriptores optimi quique veteres et recentiores*," etc. The book contains the works of Jean Tagault, of Jacob Holler, of Marianus Sanctus, of Angelus Bologninus, of Michael Angelo Biondo, of Bartolomméo Maggi, of Alfonso Ferri, and of Joannes Langius, together with the treatises of Galen on bandages, and of Oribasius on fractures and luxations, and the machines for their adjustment. To all of which is added an account of the medicines employed in surgery, by Jacob Dond, and remarks on the excellence and antiquity of surgery, by Conrad Gesner. I mention this book as an example of the ponderous treatises on surgery which were in use at the time which I am now considering. The work was amply illustrated with large wood engravings of many very interesting surgical instruments then in use. The volume is rich in treatises on the cure of wounds of all sorts, but particularly those made with fire-arms. I advise the curious reader to hunt in the libraries for this collection, wherein he will find a world of interest. There are figures of the *Alfonsinum*, and numerous other bullet-forceps, almost, if not quite equal to the best now in use. There also he will see the lithotomy instruments of Marianus Sanctus, his grooved-staff, his spoons, scoops, forceps, etc.

John Woodall, a distinguished English military and naval surgeon, was born about the year 1549. He served in France as surgeon with the troops sent by Queen Elizabeth to the aid of Henry IV. He was a surgeon of St. Bartholomew's Hospital, and surgeon-general of the East India Company. He wrote a book which became quite famous, entitled "The Surgeon's Mate" (1617), also the "Viaticum, or Pathway to the Surgeon's Chest" (1620), and several other works. He was the first to suggest amputation of the leg as low as the ankle, in diseases and injuries of the foot. This hint he obtained from travellers in the East Indies, who had seen cases of persons who had undergone the punishment of having their feet chopped off, and who had recovered, being able to walk very well by putting the stumps into cases of bamboo. I find in his "Surgeon's Mate," that he follows the same practice, laid down by Clowes, in arresting hemorrhage after the "dismembering" or amputation of limbs, viz: the "buttons" and "restrictive powder." He evidently regarded the dismemberment of a limb as an exceedingly serious operation, giving the following admonitions:—

> If you be constrained to use your saw, let first your patient be well informed of the eminent danger of death by the use thereof, prescribe him no certaintie of life, and let the worke be done with his owne free will and request, and not otherwise. Let him prepare his soule as a ready sacrifice to the Lord by earnest prayers; craving mercie and helpe unfainedlie: and forget thou not also thy dutie in that kinde, to crave mercie and helpe from the Almightie, and that heartily. For it is no small presumption to dismember the image of God.

He tells us in his Treatise of Gangrena and Spachelos (1639) that he had been a surgeon for "the space of 50 yeares," and that "for the space of nere 24 yeares" he had been a surgeon in the Hospitall of St. Bartholomews, where he had "taken off, and holpen to take off many more then one hundred of legges and armes," "and further-more I affirme that not above foure of each twenty dismembered, but lived to have beene healed." No marvel, then, that he should have dread of dismembering the Image of God.

Franciscus Arceus, a celebrated Spanish surgeon, was born in 1493, and died in 1573. He had an ample experience in the wars of that period, and wrote a work on the cure of wounds, which became very famous, being first printed in Latin, in 1574, at Antwerp. It was translated into German, Dutch, and English.[1] He was a strong advocate of turpentine in the cure of wounds.

Rhinoplasty had, no doubt, been practised more or less crudely through all the ages from the time of Celsus to the middle of the sixteenth century. The restorer and champion of this variety of surgery was Gasparo Tagliacozzi, or Taliacotius, as we commonly see the name printed. He was a celebrated professor of anatomy and surgery in the University of Bologna. He was born at Bologna in 1546, and died in the same city in 1599. His great work "De Curtorum Chirurgia per Insitionem, libri duo,"[2] with its twenty-two *Icons*, is classical, monumental, and justly famous. "The Taliacotian operation," for the restoration of the nose, is described in all modern works on surgery.

Fabricius ab Acquapendente (1537–1619) was a celebrated anatomist and surgeon, who was professor of these departments in the University of Padua for many years, being the successor of the distinguished Fallopius, and the master of the renowned Harvey. Jerome Fabricius has been styled the father of modern surgery. He made many improvements in both the science and art of surgery, his works being so highly esteemed and so eagerly demanded that no less than eighteen editions were published, in various languages and in different countries, extending over a period of one hundred years.

Josephus Quercetanus, Joseph du Chesne, or Quesne, or Duchesne, was born in 1544, and died at Paris in 1609. He was physician of Henry IV., and associated with Guy Patin and other celebrities of the court. He was the author of many works on medicine and surgery. Those of most importance to our art are his treatises on the cure of gunshot wounds, which were published at Lyons in 1576, and translated into English by John Hester, and published in small quarto at London in 1590, with the following title: "The Scloptarie of Joseph Quercetanus, phisition, Or His booke containing the cure of wounds received by shot of Gunne or such like *engines of warre.* Whereunto is added his Spagericke antidotary of medicines against the aforesaid woundes." All the old errors of venom in gunshot wounds, the compounding of complex unguents, and the like, are taught by this author. It is historically interesting as showing the state of military surgery at that date; it is curious, and now quite a rare book.

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[1] By John Reed, Chirurgeon. 4to. London, 1588.

[2] Published at Venice, in folio, 1597.

Felix Wurtz, or Wurtzius, of Basle, who flourished about 1575, wrote a work on surgery which was translated from the German into English, and published at London, in small quarto in 1632. This "Book of that famous and well expert surgeon Felix Wurtz, Citie Surgeon of Basell," had already been reprinted twenty-eight times in German, and also several times in Belgic, during the previous half century. It was chiefly devoted to the "Cure of all sorts of Wounds in Mans Body, from the Head to the Toe." It treated also of "other Infirmities belonging to Surgerie;" as well as "of all kinds of Balmes, Salves, Plaisters, Ointments, Oyles, Blood-stenchers," etc. It is in books of this sort that we are made familiar with the every-day surgery of the period.

There is yet a multitude of surgical treatises still extant, which were written and published in the sixteenth and seventeenth centuries, and which possess more or less interest historically, but limited space precludes even the briefest mention of their titles, far less an analytical digest of their contents. Those which have been cited, or may yet be referred to, are such as were most famous, and most worthy of note, on account of containing improvements in surgical practice, or those that exercised the most potential influence in the correction of contemporary errors.

Among the interesting monumental works on surgery, none is more curious or worthy of mention than that of Joannes Andreas a Cruce, or, as the French write his name, Jean André Delacroix. This work was first published in his native city of Venice, in folio, in 1573. From the number of its editions the work must have been in great demand. It is profusely illustrated with wood engravings. It is here that we find pictures of the greatest number and variety of the instruments used by the ancient chirurgeons. More than a hundred engravings are devoted to trephines and other instruments used in operations upon the head; to which are added quite large scenic pictures of operations, with surgeons, attendants, domestic interiors, family, dogs, cats, and mice. There are two full-page pictures of battles, with army surgeons in the foreground, engaged in operating upon the wounded (pp. 126, 131); also figures of all the forms of arrow-head mentioned by Paulus Ægineta and the Arabian writers, with the instruments needed for their extraction. There is much surgical anatomy interspersed in the various sections of this grand old treatise.

Giovanni di Vigo, a native of Genoa, flourished towards the end of the fifteenth and the early part of the sixteenth centuries. He wrote a very complete treatise with the following title: "Practica in Arte Chirurgica copiosa, continens novem libros." He was the physician and surgeon of Julius II., and resided in Rome, at which place the first edition of his work was published, in folio, in 1514. It was published in many places, and translated into many languages, in the course of two centuries, being highly esteemed as a standard authority. It was published in English, at London, in 1543. In the dedication, the translator says: "I thynke that nothyng canne better testifie and proove the connynge of this man, than that he continued so long with so greate prayse, practysynge at Rome in such a multitude of curtisanes, neyther priestes, bysshopses, nor cardinales excepted, as it playnlye appeareth in his book."

Gulielmus Fabricius Hildanus, who was distinguished after the manner of Hieronymus Fabricius ab Acquapendente, by Latinizing the name of his place of nativity, was born in Hilden, near Cologne, in 1560, and died in the year 1634. He was the most eminent German surgical writer of the sixteenth and seventeenth centuries. He wrote a large number of treatises on different subjects relating to this department of the healing art. He was the first to collect and report interesting cases of surgical diseases and operations. Six *centuries*, as he styled each of his series of one hundred cases, were published at different times, and these, with his other treatises, were collected together and published, under the title of Opera Omnia, in a ponderous folio, in 1646, forming a work of great interest and value. About this time there was instituted in Germany a serial, annual publication, under the name of *Ephemerides.* It was continued for many years, and until medical and surgical journals were established. This work became the repository of many very important surgical cases, and constitutes a valuable addition to the surgical literature of the period.

Johann Scultz, or Joannes Scultetus, was born at Ulm in the year 1595, and died in 1645. He was an eminent surgeon, and author of a work on the instruments employed in surgery, which bore the title "Armamentarium Chirurgicum XLIII. Tabulis Æri elegantissime Incisis, etc." It is a work that was of great importance, and so renowned that it was published in various languages and countries, and for a period of nearly a hundred years. No less than a score of editions were published from 1653 to 1748; two were in folio, five in quarto, and thirteen in octavo. It was first published at Ulm, in 1653, in folio, eight years after the death of the author. In the forty-three plates there are beautifully illustrated many hundreds of ingenious surgical instruments, both ancient and modern. Here can be seen almost all instruments, or at least the suggestion of nearly all, that are now used in surgery, among which are many that are in these days known by the names of very recent inventors. It is an old quarry which has been extensively worked. This is the pioneer of surgical "armamentariums," of which a large number have since appeared, mostly from instrument-makers to advertise their wares. Not so, however, with the grand folio of Seerig, with its 145 plates containing over five thousand figures of surgical instruments (1835–8).

The invention of gunpowder and of fire-arms marks an epoch in the history of surgery. While the soldier was struck with consternation by the wholesale slaughter which resulted, the surgeon was equally dismayed by the mortality which was occasioned by this novel variety of wounds, and at the same time much perplexed and greatly baffled in his attempts to treat them. Pierre Dionis, a French surgeon, who wrote a treatise under the title of "A Course of Chirurgical Operations," which first appeared in 1707, thus speaks of the invention of gunpowder: "Some ages since there came out of Hell a Monster, in the Habit of a Monk, who trying chymical experiments, invented a Composition of Saltpetre and Sulphur, which we call Gunpowder. This diabolical invention," etc. The great obstacle to the proper treatment of this class of wounds arose from the erroneous conception that gunpowder was poisonous, and that the velocity of the ball generated so great a heat as to destroy the tissues with which it came in contact in its course through any portion of the body or limbs. These errors were difficult to correct, and many years of time were required, unspeakable tortures were needlessly inflicted, and thousands of human lives were sacrificed, before the world learned to trust to nature, to cleanliness, and to simple dressings. Thus the treatment of wounds passed from the safer plan of expectancy, through the medium of charms, prayers, and incantations, to the course of barbarous interference, by the use of boiling hot oils, the actual cautery, and the vilest of irritating unguents.

To all of which must be added the "vulnerary beverages," "weapon salves," and "sympathetic" and "magnetic powders."

Among the many surgical writers of the seventeenth century was Matthew Godfrey Purmann (or Purmannus), who was styled "chief chirurgeon of the city of Breslau." He wrote several important surgical treatises which were published at Frankfort, and at Jena. Purmann served in the army from 1674 to 1679. His works were written in "High Dutch," and only one of them was translated into English, viz: his "*Chirurgia Curiosa;* or the newest and most curious observations and operations in the whole art of chirurgery," etc., which appeared as a folio, at London, in 1706, having been first published at Frankfort, in quarto, in 1694, and lastly at Jena, in quarto, in 1715. The English edition was "illustrated with large chirurgical figures, of patients as well as instruments, invented by Dr. Solingen, curiously engraven on copper plates." This work is curious indeed, and must have been useful in its time; it is replete with cases, and sets forth the secret and other remedies, as well as operations of that day. I mention it partly on account of its rarity, and partly to refer to the strange notion which once extensively prevailed among surgeons, concerning the cure of wounds by sympathy, by transplantation, and by the use of "weapon salves." These are treated of in Book III., Chap. V., of Purmann's work. He gives the formula for the weapon salve, among the ingredients of which are earth worms, human mummy, swine's brain, magnet, and "the moss of a man's skull that was either kill'd or hang'd, and gather'd when the star *Venus* is predominate." He tells us, "this *Unguent* I had always with me in the camp, and have often used it with good success." The following are the directions for its employment: "Take the weapon or instrument wherewith the patient was wounded, while it is bloody, or instead of it a stick put into the wound that it may be bloody. Anoint it with the unguent about a hand's breadth, and wrap it up in a clean linen rag or paper, your hands being very clean, and then lay the weapon or stick in a place neither too hot nor cold; two or three days after anoint it again, and so for four or five times till the wound is well. The patient in the mean time must keep the wound clean, and cover it with a fine linen rag, without applying any medicine to it." Then follows a case cured in this manner. This delusion of magnetical and sympathetic influence, when exploded, must have had a great effect in simplifying the treatment of all kinds of wounds, since it was made manifest that thorough cleanliness and exclusion of the air were the only elements requisite to aid the natural cure. Space will not admit of further detail regarding this myth. The reader will find much that is curious on the subject in the works of Purmann, Sir Kenelm Digby, Paracelsus, and Van Helmont. It would require a volume to tell the story fully.

The history of surgery would be very incomplete if the name and works of Richard Wiseman were omitted. He was sergeant-surgeon of Charles II., and enjoyed the advantages of a long and valuable service in the civil wars of England. He became very eminent, and has been styled the Ambroise Paré of the Britannic nation. His "Eight Chirurgical Treatises" constitute the most valuable contribution to surgery that had ever been made in that country down to the time at which they appeared. They have been, and ever will be, regarded as the most precious monument of English surgery. They were published four times in folio, 1676–1705, and twice in octavo, 1719–1734. These treatises abound in very sensible and highly practical observations. Among other precepts is the following, which relates to the important question of the propriety of immediate amputation in cases of severe gunshot wound, and which was laid down almost two hundred years in advance of its final confirmation and adoption by modern military surgeons. Wiseman says: "In heat of fight, wether it be at sea or land, the chirurgeon ought to consider, at the first dressing, what possibility there is of preserving the wounded member; and, accordingly, if there be no hopes of saving it, to make his amputation at that instant, while the patient is free of fever." In another place Wiseman speaks of the importance of posture in the reduction of hernia, and mentions an engine, as he calls it, for holding a man with his heels above his head, for this purpose. He also argues in favor of a cutting operation in strangulated hernia. Pins were his favorite means of coaptating wounds, by the use of which he recognized the superiority of metallic sutures. His treatises are eminently worthy of a careful perusal even at this day. With all his sound sense and ripe experience, he was, nevertheless, superstitious and credulous in reference to the efficacy of the Royal Touch in the cure of scrofula, or the king's evil, as it was termed. He declares that "his majestie cureth more in any one year than all the chirurgeons of London have done in an age," and also avers that "I myself have been a frequent eye-witness of many hundreds of cures performed by his Majestie's Touch alone, without any assistance of chirurgerie; and those, many of them, such as had tired out the endeavours of able chirurgeons before they came thither."

Lawrence Heister, and his "General System of Surgery," deserve a brief notice. Heister was born at Frankfort on the Main, in 1683, and died in 1758. He was a pupil of the celebrated anatomists, Ruysch and Rau, of Amsterdam, and an accomplished army surgeon, having had ample experience in 1707–9, in the war between the French and Dutch in Flanders. He wrote a large number of surgical dissertations and treatises, some of the most important of which were on wounds, particularly those by gunshot. At the time that his work on surgery was written, no similar treatise existed in Germany, in which country great ignorance and want of skill existed among surgical practitioners. His treatise was an admirable one, and was published in many languages, and in many countries. First in German, at Nuremberg, in 1718, and subsequently in French, Spanish, Italian, Latin, and English, the translation into the last-named language having been published in quarto, at London, in 1748. It was profusely illustrated with a large number of handsome copper-plate engravings, in which not only the instruments, but also the operations themselves, were most graphically exhibited, even to the extent of showing the surgeons and their assistants, with all the accessories, actively engaged. This "system," and Heister's large volume of "cases," were important additions to surgical literature.

James Young, an English surgeon, of Plymouth, and a contemporary of Wiseman, published a treatise on several surgical subjects, at London, in the year 1679. A portion of the title of this book read thus: "with a new way of amputation and speedie method of curing stumps." Whatever value the flap operation in amputations may possess, it is to Lowdham, of Exeter, and to James Young, that the credit of being the first to propose and describe it must be awarded.

One of the most distinguished surgeons of France in the eighteenth century was Jean-Louis Petit, who was born in 1674, and died in 1750. He was the inventor of the screw-tourniquet, still in common use. His treatise on the Diseases of Bones was the first of its kind. The first edition appeared in 1705. It was soon translated, and published in many languages and countries. Petit did much to improve surgery, and was highly honored, the king naming him Director of the Royal Academy of Surgery, and appointing him his own First Surgeon.

"The Chirurgical Works of Percivall Pott" are contained in three handsome octavos, which embrace some of the most valuable contributions ever made to surgical pathology and practice. He was born in 1713, and died in 1788, having lived during three-quarters of the eighteenth century. As boy and man, or student and master, he served fifty years of his life in St. Bartholomew's Hospital. His descriptions of caries of the vertebræ and spinal curvature were so accurate and vivid that they are regarded as truly classical, and will ever be remembered as long as the name of "Pott's Disease" shall be written or spoken by surgeons. The beautiful engravings of spinal caries with which his book is illustrated are works of art. His treatment was conservative. He suggested relieving the lower limbs and spine from pressure, by using supports under the arms, and placed much reliance on the use of issues. Pott did not approve of "back-board collars, steel-bodice, swings, screw-chairs, and other pieces of machinery," which, he says, are used, "but all to no purpose."

John Hunter was, unquestionably, the most distinguished anatomist and surgical pathologist of the eighteenth century. He was born in 1728, and died in 1793. He was a pupil of the celebrated Wm. Cheselden, and of the eminent Percival Pott, two of England's greatest surgeons. He wrote a treatise on venereal diseases. His description of a true chancre was so graphic that the lesion in question will ever bear his name—*The Hunterian Chancre.* His "Treatise on the Blood, Inflammation, and Gunshot Wounds," is a monument of painstaking investigation and sound judgment; its influence on surgical theory and practice was very important. Hunter's operation for aneurism was scientific and successful. His theory taught that the artery should be ligated at a considerable distance from the aneurism, on the cardiac side, in order to secure a sound portion of the vessel, since he had observed that the artery was generally diseased near the dilatation. He was the first surgeon who ever tied the femoral artery for popliteal aneurism. Hunter had a large experience as a surgeon in the Peninsular War. His enthusiastic love of comparative anatomy and natural history is universally known. The formation of the Hunterian Museum of 14,000 specimens, at a cost of seventy thousand pounds sterling, was a great achievement for a single individual. It is a fitting honor that his remains lie under a monument, erected by his professional friends in all parts of the world, and that remains and monument are placed with Britannia's noblest dead in Westminister Abbey. It is also fitting that the Royal College of Surgeons should be the conservator of his museum, and that each returning year his merits and example should be extolled in an Hunterian oration.

Pierre-Joseph Desault was born in 1744 and died in 1795. He was the first to give systematic courses of lectures on surgical anatomy, and clinical lectures on general surgery. He invented many surgical instruments and many pieces of surgical apparatus. The Desault fracture-splint was the first device for continuous extension. He also invented the straight amputating knife. He divides with John Hunter the honor of pointing out the true method of curing aneurism. He was the editor of the "*Journal de Chirurgie*," the first periodical devoted to this department of the healing art. His sudden death is said to have been caused by poisoning, while in attendance upon Louis XVII. His successor, Chopart, and likewise Doublet, who also attended the dauphin, both followed Desault to the grave within four days.

The surgical student of the present day ought to carefully read the history of the discovery of modern anæsthesia. Ages, indeed many centuries, previous to the nineteenth, a considerable number of anæsthetics were known and used by surgeons. The poppy, henbane, mandragora, hemp, etc., were known to deaden pain. Herodotus says that the Scythians inhaled the vapor of hempseed to produce drunkenness. In the year 220, Hoa-tho, a Chinese surgeon, administered haschish, and performed perfectly painless amputations, the patients slowly recovering from the stupor. Pliny, writing in the first century, states that "Mandragora was drunk before cuttings and puncturings, lest they should be felt." Dioscorides describes the mode of preparing this anæsthetic, for use in those who were to be cut or cauterized—"or sawed," adds Dodoens, his commentator—that they "do not feel pain." Apuleius, of the next century, says that half an ounce of this, with wine, will cause the patient to sleep during an amputation, "without sensation." The "*spongia somnifera*" of Theodoric (A. D. 1298) was inhaled before operations. M. Dauriol, in 1832, gives five cases of insensibility during surgical operations, induced by the use of a similar narcotic sponge.[1] It was reserved for the United States of America to discover methods of anæsthesia which were complete, inevitable, and safe, in place of stupefaction, partial, occasional, and dangerous. And this was done in October, 1846. "In three months," says Bigelow, from this date, "ether anæsthesia had spread all over the civilized world. No single announcement ever created so great and general excitement in so short a time. Surgeons, sufferers, scientific men, everybody, united in simultaneous demonstration of heartfelt mutual congratulation."[2]

The discovery of anæsthesia has proven an inestimable boon to suffering humanity, not only in annihilating or mitigating pain during operations, but also by enabling surgeons to undertake operations, otherwise utterly impracticable or impossible of performance. Abdominal surgery has been almost created during the present century. The removal of enormous ovarian tumors has been rendered possible, and has been practised in thousands of cases, and with surprising success. The name of Dr. Ephraim McDowell, of Danville, Ky., will always be remembered, with a thrill of genuine pride, by every American surgeon, as the universally admitted pioneer in this great operation, and the very first ovariotomist in the world. He first performed this operation, which will bestow immortal fame upon him, in the year 1809, more than a third of a century before anæsthesia was discovered. The names of his eminent followers, Atlee, Peaslee, Spencer Wells, and many others, who, in the aggregate, have added thousands of years to the life of women, will also be forever famous in the annals of humanity.

A large volume would prove inadequate to fairly set forth the extraordinary surgical achievements which have been accomplished thus far during the nineteenth century, and to assign to each surgeon his just due for his part in the truly marvellous progress which has been made, at home and abroad, during this brief period of time. The names of Dupuytren, Roux, Lisfranc, Velpeau, and Nélaton, of France; Abernethy, Cooper, Brodie, Fergusson, and Lawrence, of England; Crampton, Colles, and Hamilton, of Ireland; Bell, Syme, Liston, and Simpson, of Scotland; Graefe, and Rust, of Germany; Scarpa and Porta, of Italy; Physick, Barton, Mütter, Norris, Pancoast, and Gross, of Philadelphia; Wright Post, Kissam, Rodgers, Watson, Stevens, Mott, Van Buren, Parker, and A. C. Post, of New York; Nathan Smith, of New Haven; the Warrens and Hayward, of Boston; N. R. Smith, of Baltimore; Warren Stone, of New Orleans; Dudley, of Lexington; Brainard, of Chicago; Eve, of Nashville; and Hodgen, of St. Louis; represent but a few of the eminent surgeons who have labored successfully, during the present century, to extend the borders of their art, and have glided away from earth to their everlasting home, beyond the scenes of sickness, suffering, and death. Hundreds more have filled up the ranks, who are worthy followers of those who have dropped out; they are toiling on; they have the advantage of all past experience; they live in an age of unprecedented progress in all that relates to science, art, and the humanities in general. The time has not yet, but soon will, come, when their achievements will form an important chapter in the history of surgery.

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[1] See Bigelow's History of the Discovery of Modern Anæthesia, in A Century of American Medicine, 1776–1876, pp. 73–112. Philadelphia, 1876.

[2] Ibid., p. 80.

Every now and then the world is amazed by the appearance of a genius, who, in a few short years, does the work which all previous centuries had failed to do, teaches his lessons well, becomes immortal, and flits away. It is impossible to speak too highly of such an one who has just departed. Gynæcology scarcely had an existence previous to the commencement of J. Marion Sims's brilliant and successful operations for vesico-vaginal fistulæ. There is nothing in the whole domain of surgery at all comparable with this man's contributions to gynæcology. He taught how to effect the absolute and permanent cure of the most distressing and loathsome condition of woman which it is possible to imagine, resulting from the injuries and lacerations incident to difficult childbirth, a condition which the most skilful surgeons had, up to that time, utterly failed even to ameliorate; frankly and freely, and without remuneration, to go forth to all the principal civilized nations of the earth, personally and unreservedly to teach the surgeons of the world all his methods, and to establish model hospitals for the benefit of multitudes of afflicted women, furnished an example of broad and generous humanity, and of unselfishness, to which the world had before been a stranger. Dr. Sims well merited all the appreciation, admiration, and glory, which were rather tardily bestowed upon him. In future, the civilized world will never cease to express its unlimited gratitude for his eminent services, and this will be repeated age after age, as long as the primeval curse shall rest upon woman, and until she shall enter upon a millennium when sickness and disease shall be no more.

The wonderful results of Bigelow's process of rapid lithotrity, mark another immense stride in operative surgery. The Listerian method of antiseptic treatment of wounds, with all that relates to simplicity, cleanliness, germ-destruction, and the like, has opened a new era in our art. The vast experience furnished to military surgery by the great American Rebellion and other wars in this century, the systematic record of the stupendous mass of material obtained, its careful study and analysis, the principles evolved, and the liberal publication of all under government patronage, particularly our own, marks an epoch in surgical history. The great advances which have been made in the science and art of surgery during the nineteenth century, are recorded in the several articles of the six ponderous volumes of this International Encyclopædia. The century of surgery, last past, has entirely recast and completely remodelled this whole department of the healing art.

If this imperfect sketch of the history of surgery, which has been written in the most fragmentary manner in the brief intervals of an active practice, shall awaken an interest in the mind of any student, and incite a desire for a more complete knowledge of the subject, he may be referred to an ample list of valuable authorities, more or less incomplete, which will prove very helpful to him in his researches. He will, however, experience no small surprise at the meagreness of medico-historical literature in our own language, and particularly that by American authors. The French and German languages will afford him a far richer field for the culture of this delightful study.

The biographies of physicians and surgeons in this country by Thatcher, Williams, Gross, Atkinson, and a few lesser and local works, are nearly all that can be found, excepting single sketches, privately distributed or buried in the transactions of societies or in medical periodicals. The historical addresses of Dr. John B. Beck and Dr. John W. Francis, with the brief epitome of medical history by Dr. Dunglison, are about all that we have to offer on this subject. To these we can add Renouard's History of Medicine, which has been translated from the French and republished in this country. Great Britain has produced brief histories by Freind, Aikin, Lettsom, Walker, Black, Hamilton, Bostock, Moir, Wise, Davis, Meryon, and a few others. There have only been translated from the French and published in England the histories of Le Clerc and Cabanis. In the German tongue there are many works on the history of medicine and surgery. The student will want to read the treatises of Schulze, Sprengel, Hecker, Choulant, and Morwitz, In French many excellent historical works will be found relating to our profession. Besides all of these the student will derive much satisfaction and extensive information from the numerous bibliographies of medicine and surgery. Haller's *bibliothecæ* of anatomy and of surgery, each in two quartos; Éloy's *Dictionnaire Historique de la Médecine Ancienne et Moderne*, 4 vols. 4to; Dezeimeris's work with the same title, 4 vols. 8vo; and Jourdan's *Biographie Médicale*, 7 vols. 8vo; are among the most valuable of this character. We are sadly in need of a comprehensive history of anatomy, medicine, and surgery, in the English language.

DESCRIPTION OF PLATES IN VOL. VI.

PLATE XXXIII. (Page 169.)

VARIOUS FORMS OF URINARY CALCULUS.

Fig. 1. Alternating calculus, showing on section multiple nucleus of oxalate of lime, waving lines of oxalate-of-lime formation surrounding the nuclei, then alternating layers of uric acid, urate of ammonium, oxalate of lime, and phosphates, succeeding each other. Natural size. (From the collection of Van Buren and Keyes.)

Fig. 2. Uric-acid calculus, showing on section concentric lamination about the nucleus of uric acid, waving lines of oxalate of lime, and radiate structure of uric acid beyond. Natural size. (From the collection of Van Buren and Keyes.)

Fig. 3. Mulberry calculus; oxalate of lime. Natural size. (From the collection of Van Buren and Keyes.)

Fig. 4. Kidney-stone of xanthic oxide, now in Army Medical Museum, Washington, D. C.; described by Dr. G. L. Porter, of Bridgeport, Conn., in New England Medical Monthly, May, 1882.

Fig. 5. Kidney stone of cystine, in the possession of Dr. Robert F. Weir, of New York.

Figs. 6, 7. Mixed phosphatic calculi, showing formation on foreign body (bit of althea root) and excentric position of nucleus. Both stones represented of natural size. (From the collection of Van Buren and Keyes.)

PLATE XXXIV. (Page 550.)

TUBERCULOSIS OF TESTIS AND ELEPHANTIASIS OF SCROTUM.

Fig. 1. Tuberculosis testis. (*a*) normal tube; (*b*) epithelium becoming detached; (*c*) epithelium has coalesced in the centre of a tube; (*d*) epithelium has formed a giant-cell. (Beck, $\frac{1}{2} \times 155$.)

Fig. 2. Shows the appearance presented by a giant-cell. (Beck $\frac{1}{6} \times 300$.)

Fig. 3. Elephantiasis scroti, a section of its superficial part: (*m*) non-striated muscle, seen in transverse section; (*l*) lymphoid tissue. (Zeiss BB $\frac{4}{10} \times 100$.)

Fig. 4. Elephantiasis scroti, a section of its deep tissues which are separated by maceration: (*f*) band of fibrous tissue; (*l*) lymphoid tissue; (*p*) plasma cells. (Zeiss DD $\frac{1}{6} \times 300$.)

PLATE XXXV. (Page 555.)

FIBROMA AND CARCINOMA OF TESTIS; RETAINED TESTIS; EPITHELIOMA OF SCROTUM; SYPHILITIC TESTIS; DIFFUSE ORCHITIS.

Fig. 5. Fibroid testis; in place of the normal structure there is seen ordinary young fibrous tissue, in parts approaching to myxomatous tissue. (Beck $\frac{1}{6} \times 300$.)

Fig. 6. Carcinoma testis; the alveoli containing the cancer cells are well seen. (Beck $\frac{1}{2} \times 155$.)

Fig. 7. Retained testis; the membrana propria of the tubes is much thickened, and destitute of the highly-developed epithelial cells which normally line the tubes and secrete the spermatozoa. (Beck $\frac{1}{2} \times 155$.)

Fig. 8. Epithelioma scroti; at (*a*) is seen an altered hair-follicle; (*b*) a mass of large epithelial cells; (*c*) stroma with small cells. (× 200.)

Fig. 9. Syphilitic testicle; the whole gland is converted into a round-celled, fibrous mass; in the centre is a bloodvessel showing an in-growth of fibrous tissue; in the oldest portion of the tumor nothing is to be found but dense fibrous tissue, with a few round cells, the vessels having entirely disappeared.

Fig. 10. Diffuse orchitis; a band of fibrous change is seen passing across the testicle; above and below are the seminal tubes. (× 100.)

NOTE.—The microscopic illustrations embraced in Plates XXXIV. and XXXV. are from drawings by Dr. Heneage Gibbes, Lecturer on Physiology and Pathology at the Westminster Hospital, London.

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